JANUARY • 1947
VOLUME XVIII NUMBER 4

the Petroleum Engineer

...ods for Operating Men

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March 2-5—American Society of Mechanical Engineers, spring meeting, Mayo Hotel, Tulsa, Okla.
March 12—Institute of Petroleum, Manson House, 26, Portland Place, London, W. 1, England.
March 17-22—AIME, 75th annual meeting and world conference on mineral resources, Waldorf-Astoria Hotel, New York.
March 22-28—Western Metal Congress and Exposition, San Francisco-Oakland Golden Gate area, California.
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DRILLING AND PRODUCTION

Diamond Coring at Rangely, Colorado—Robert W. Stuart 43
Diesel Electric Barge Rig, 2100-Hp, Designed to Drill 15,000-Ft Wells—K. Marshall Fagin 49
The Gas Industry in 1946—R. H. Hargrove 66
Quick Freezing Seals Fluid Content in Cores—John D. Wisenbaker . . . 75
Pumping Unit Design Lowers Rod Acceleration—J. B. Wrigley 92
Liner Job Well Remedial Work in East Texas Field—D. W. Akins . . . 96
Classification of Oil Discoveries and Fields 124
The Petroleum Engineer as a Supervisor—Thomas C. Frick 160
Gas Developments and Trends in South Texas—C. R. Williams 174
Applying Plastic Coating to Oil Tanks—William J. Davis 182

REFINING AND NATURAL GASOLINE MANUFACTURE

Hydrocarbons in Petroleum—Frederick D. Rossini 58
New Fluid Catalytic Cracker Design 88
Evaluation of Absorber Operating Efficiency (Part 2, Conclusion)—E. G. Ragatz and J. A. Richardson 110
Liquid Petroleum Gas in 1946—G. G. Oberfell and R. W. Thomas . . . 140
Conversion of Natural Gas to Liquid Fuels—R. C. Alden 148

OIL AND GAS TRANSPORTATION

How Gas Was Put Through Big Inch Lines—Frank H. Love 53
The Transportation of Natural Gas—D. A. Hulcy 120
Simplified Pipe Line Computation (Part 3, Conclusion)—Peyton Bryan . . 178
Weed Chopper for Pipe Line Work—O. C. Irvine 202

GENERAL

A New Approach to Mechanical Orifice Meter Chart Computation—W. F. Martin 106
The Pattern for Decision—E. Daniel Hayward 164
Safety Program in Saudi Arabia—R. A. Coughlin 190

REGULAR FEATURES

The Course of Oil 12
Scanning Washington's Oil Horizon 14
National Petroleum Situation ..... 16 and 17
Highlights in Oildom 18
Current Oilfield Operations 20
Pipeline Developments 22
Refining and Natural Gasoline Activities 24
Machinery and Equipment 131-136
Trade Literature 138
Running Tour With Men in the Industry ..... 196, 198 and 199
The Petroleum Engineer's Continuous Tables (Installment No. 115) 211-226
Laugh With Barney 200
Pacific Personalities 234
Book Reviews 236

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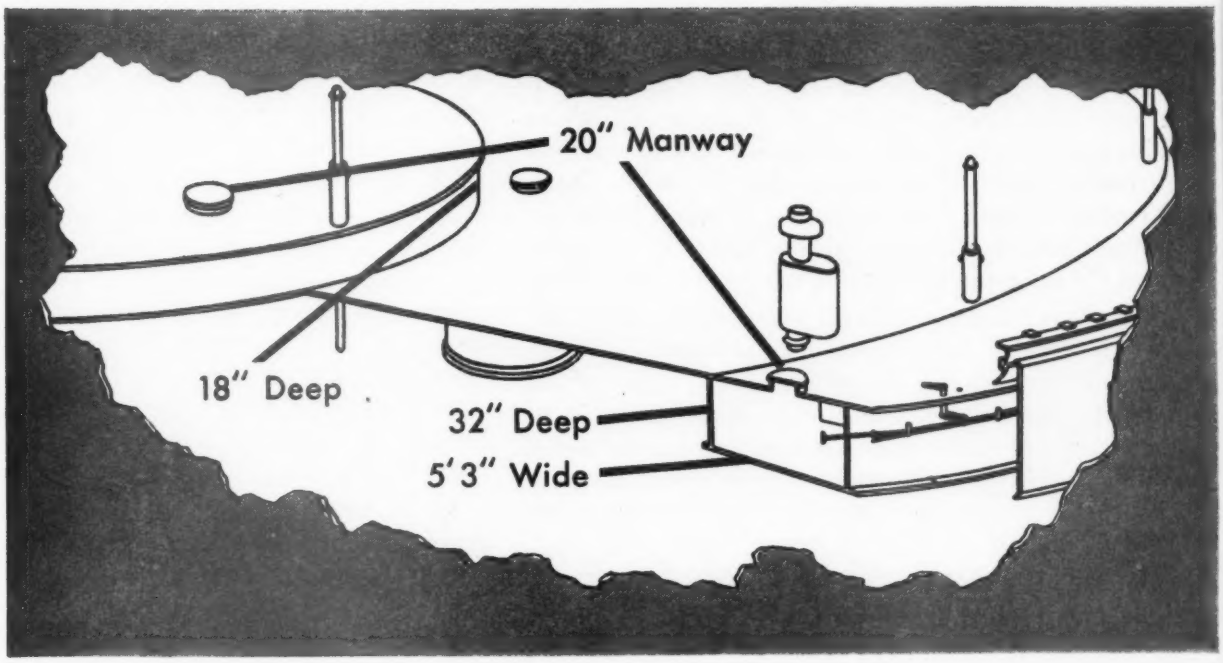

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OIL'S RESPONSIBLE JOB

In looking back over what happened to the oil industry in 1946 it is not the actual events but what they portend that becomes important.

After four strenuous years of fueling a war that encircled the globe, there has been no resting, no reaction of inertia. The oil industry has the characteristics of a good spring thaw. It is germinating greater plans than ever before. It is faced with an increasingly responsible job and it has never been in better condition to meet it. In the United States it confronts the largest peacetime demand in history for petroleum products. Abroad there is a crying need for the essential oil products for reconstruction.

The world is searching for economic stability and an opportunity to progress. The oil industry is an integral part of the economic advancement of the United States and it must be an important part of the world's progress. Already it is pushing the world toward industrial recovery with those dynamic qualities that first appeared after the Civil War in the United States.

In South America, Venezuela has become the second largest oil-producing nation in the world. Chile has found its first commercial production. Bolivia is getting a loan to expand its drilling and pipe line program. New fields are appearing in out-of-ways places and settlements and roads and schools follow them.

In the Middle East, plans involving hundreds of millions of dollars are afoot for the expansion of oil operations. Pipe lines are projected from Iran and Saudi Arabia; drilling activity is beginning in Lebanon; exploration is under way in Ethiopia; production around the Persian Gulf is being increased.

In the Far East, the work of reconstruction has begun. The Philippines has contracted for a large drilling program delayed by the war. The Allied Military government has approved an oil exploration program for Japan. China seeks American help to develop the oil resources within its borders.

In the United States, as if to baffle those who say our resources are running dry, the oil industry continues to find more oil than is used. Indifferent to dread predictions, it goes ahead drilling deeper into the earth, exploring the ocean bed under the continental shelf, and experimenting continually with new equipment and new methods.

The oil industry has always possessed a powerful activation that broke through any limitation to its growth and development. It has setbacks and problems but they are swallowed in the strong forward movement.

It isn't solely a profit motive that stirs its members. If the entire accounts of the oil industry were balanced for the last 88 years, the books would be in the red rather than in the black so far as money goes. In the early days a few men won but many lost; in the present, investment and risks are widely divided and so are the profits. But great are the gains in better living that have come from oil.

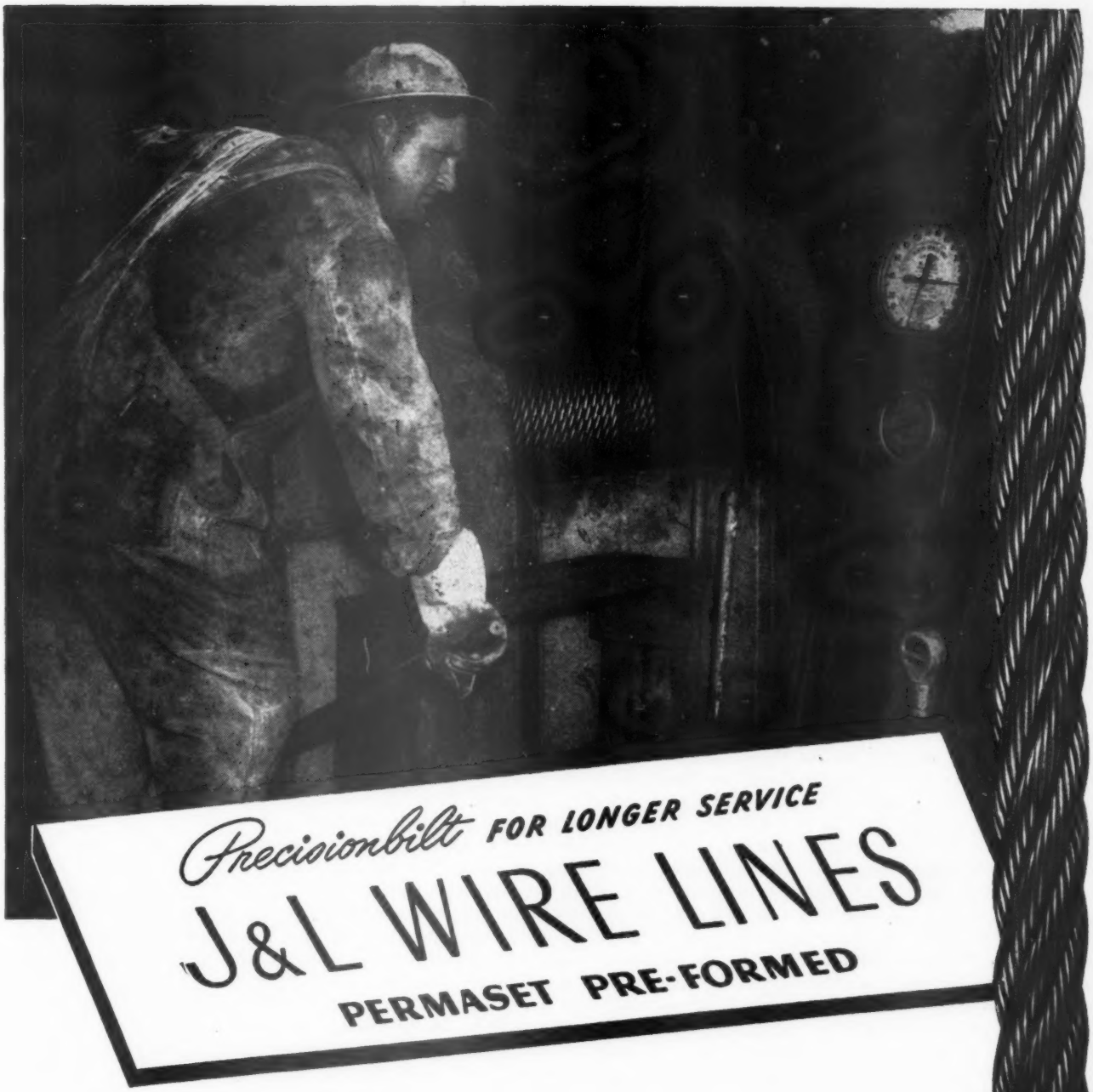
There is tough and intricate work in oil operations: Building roads over swamps and sandhills; digging slush pits in the snow or under a blazing sun; poring over maps to decide the all-important question of where to drill; propelling a huge cylinder into the sky and studying molecules in a laboratory; throwing a network of pipe lines over mountain and desert, and evolving a constantly increasing number of by-products from petroleum, many of which become basic raw materials for other industries.

There are tremendous problems to be overcome. There is the intensive search that involves travel into the far corners of the globe. Even when oil is discovered, vast problems in transportation and processing have to be overcome.

Sometimes the huge extended oil industry has trouble simply coordinating its activities, but when the job is big enough and urgent enough, a solution is usually found. Certainly the new and immediate job of supplying a needy world with petroleum products is big enough.

One problem in the New Year will be smaller, that of government in the oil industry. The United States Government has loosened war controls. Venezuela had a revolution that did not meddle with the oil industry. The Mexican government has overhauled its petroleum organization. The government of Peru is revising its petroleum laws so that American companies will be interested in exploration. The Indonesian Republic has announced it would recognize prewar oil concessions with private companies. These actions present a hopeful and encouraging sign.

There are indications that other problems carried over into the New Year may dissolve in the wake of a world-wide march of progress in the petroleum industry. With new ideas and new energy and a strong confidence in its ability to provide power and light to a weakened and darkened world, the problems of the oil industry must always look small beside its hopes and achievements.—E. A.



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SCANNING WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—Foreign oil will get increasing attention from Congress, the State Department, and military authorities during the months immediately ahead, with the Middle East oil deals sharpening the focus.

There can be little doubt now that the deals to expand American oil company participation in the Middle East concessions had the full blessing of the State, War, and Navy departments, if not actually urged by topmost officials in these departments. Also, the interlacing of British and American interests lessens the urgency for ratification of the Anglo-American Oil Agreement.

Just about the time that the first of the Middle East deals was breaking into print, Army-Navy Petroleum Board filed a policy statement with the State Department giving the military's views on proposed negotiations to reduce the oil tariff.

The military's statement was double-barreled. First, it said that barriers to importing foreign oil into the United States should be as few as is consistent with the maintenance of a healthy domestic industry; second, the American share of the Eastern Hemisphere market should be supplied out of the Middle East, reserving Western Hemisphere oil for use in North and South America. (If such a policy should be adopted, it might throw much of the Caribbean Area crude oil and products into the United States market.)

This statement of the military's oil tariff views is still shrouded in secrecy as, indeed, are most of the maneuverings here on foreign oil. And this is drawing bitter protest from Russell B. Brown, general counsel of the IPAA.

IPAA has urged that a conference be held to develop a national policy on oil imports, with domestic producers, importers, and government officials participating. But the State Department turned that down, saying that all interested parties would have a chance to state their views at the impending hearings by the Committee on Reciprocity Information on proposals to include petroleum products in tariff-cut negotiations this spring. However, Brown has been unable even to get a look at briefs filed by other parties with CRI.

IPAA's brief not only opposed a further reduction in the oil tariff but asked that the original rates be restored and that imports be restricted under a quota system.

If Brown doesn't have any luck with the State Department, he plans to take the IPAA's case to Congress. And there will be a good sounding board, if the Senate sets up an oil committee with Senator Ed Moore, Oklahoma independent producer, as chairman. Moore's group would also be consulted by the Senate Foreign Relations Committee on the Anglo-American Oil Agreement. (Moore, himself, is not convinced that ratification of the oil treaty, without some additional safeguards, would be in the best interest of the American producer.)

State Department is going through the motions of pushing for ratification of the oil treaty, arguing that if the present agreement is not ratified the "have not" countries among the United Nations may propose some sort of world oil organization that would be less acceptable to American industry.

On the House side, the oil committee (headed by Congressman Lea, California, in the last session) has filed a report that is more favorable to foreign oil, pointing out that we have fewer reserves now, hence the importance of developing South American areas, Alaska, and the Continental Shelf.

Besides foreign oil, several other issues important to the industry are likely to come up in Congress soon. Legislation to curb the Federal Power Commission has become a necessity, if the FPC is to be halted from reaching back into oil and gas production control, now that the Supreme Court has refused to upset lower court decisions in the Cities Service and Interstate gas cases. In the former, FPC included producing properties in the rate base and limited the return on a gasoline extraction plant; in the latter, FPC actually ordered a cut in the field price being paid for gas. Industry representatives view this as the most serious threat to extension of federal regulation now confronting the oil and gas industries.

Oil and gas depletion allowances may come before Congress, indirectly. Wartime depletion allowances for certain non-oil minerals were terminated on December 31. If these industries press for reinstatement of these wartime tax privileges, then the Treasury may open up the whole depletion allowance issue and renew its attack on the oil and gas provision.

Disposal of the Big Inch pipelines is back in the lap of Congress with a new policy report submitted by War Assets Administration. WAA'S report, replacing the "blue book" urging oil use of the lines, recommends that they be sold for either gas or oil, or a combination of both, to the bidder assuring the government of the highest return. WAA has backed away from its talk of an all-cash deal. Bid forms, to be opened February 10, allow payment in first mortgage bonds up to 50 per cent of the total. With railroad and coal interests girded for a last-ditch fight against gas use, prospect is that the Big Inch issue will be deadlocked for months to come.

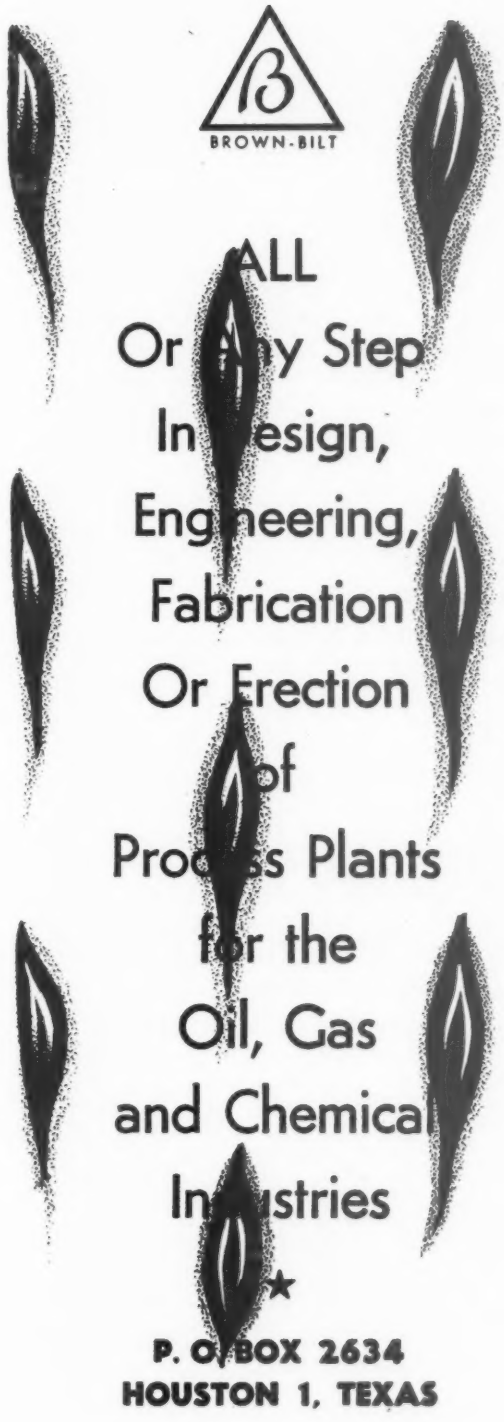
Congress, or one of its many investigating committees, probably will soon take a look at disposal of aviation gasoline plants. WAA knows this, so is rushing to dispose of the plants putting "realistic" price tags on them.

Tanker prices, too, are so high that the government is having difficulty disposing of surplus boats. So, Congress will be asked to solve Maritime Commision's dilemma by either reducing tanker prices or else providing for continued government operation of the boats, since there are not enough tankers in industry hands to meet requirements.

Tying in with Big Inch disposal is the matter of flared gas. Interior Department had wanted WAA to limit sale of the lines to gas bidders and make an award to the bidder promising to utilize the largest percentage of flared gas. But WAA Ghief Littlejohn rejected this as impractical. Now, Interior Secretary Krug may take the matter to Congress, urging that steps be taken to conserve gas that is being flared, although he may not be too specific in his recommendations.

Oil is likely to be involved in the backwash of many of the investigations now being planned on Capitol Hill and by the Executive Branch. Congress and the Truman Administration will vie for honors in probing industrial concentration, for example, and this probably will mean looking into oil company mergers and acquisitions of independent producing properties by major companies. Indeed, the Department of Justice has a headstart in this, having sent out some inquiries already.

MODERN OIL FIELD HARVEST



Flare Gas

Like the pioneer days when they stripped the hides and tallow from range cattle and left the meat on the prairies, the days of burning off gas in open flares after it has lifted one load of oil to the surface will soon be gone forever.

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national petroleum situation

By H. J. STRUTH,* *Petroleum Economist*

YEAR'S RESULTS. Preliminary figures for 1946 show that demand for all oils dropped 1.3 per cent, whereas new supply rose 2.2 per cent over 1945. Total supply of all oils, U. S. production and imports was 5,430,000 bbl. daily, and total demand was 5,279,000 bbl. daily. The excess supply, averaging 151,000 bbl. daily went into storage, mostly refined products. Imports averaged 366,000 bbl. daily; up 18 per cent. Natural gasoline and benzol averaged 320,000 bbl.

*Editor, *The Petroleum Data Book.*

HIGH PRODUCTION RATE. U. S. crude production in 1946 aggregated about 1,731,479,000 bbl., which was 20,376,000 bbl. more than the peak war year of 1945. Daily crude output was 4,744,000 bbl., representing an increase over 1945 of about 56,000 bbl. daily.

RUNS STIMULATE DEMAND. Better than expected demand for refined products in 1946 and need for stock build-ups boosted refining operations to new high level, which created tight crude supply situation. U. S. refineries consumed 1,729,972,000 bbl. of crude, which was 10,438,000 bbl. more than demand in 1945. Crude stocks only increased 22,000 bbl. daily, but refined inventories showed an increase of 129,000 bbl. daily.

STOCKS TOO LARGE. Although it was necessary for the industry to build up war depleted stocks, it is obvious that refiners were over-zealous in this respect. Stocks of all oils at the close of 1946 aggregated 518,610,000 bbl. or 55,031,000 bbl. above those of 1945. Stocks as measured by consumptive demand are at least 6 per cent above normal.

DRILLING UP 6 PER CENT. Well completions in 1946 totaled 28,656, against 27,045 in 1945. This was an increase of 1611, or 6 per cent above 1945. Wildcat well completions totaled 4303, against 4105 in 1945, a gain of 5 per cent. Oklahoma, Louisiana, and Illinois showed increases of 25, 21, and 30 per cent, respectively. California completions dropped 21 per cent, and Mississippi dropped 25 per cent.

Comparative Statistics, December, 1946

*All figures are computed on a Bureau of Mines' Basis**

	Dec. 1946(p)	Nov. 1946(p)	Dec. 1945	This year to date	Last year to date	Per cent change
Wells drilling	4,110	4,100	4,200	4,110	4,200	— 2
Total wells drilled	2,533	2,517	2,347	¶28,656	27,045	+ 6
Development wells	2,122	2,118	2,047	24,353	22,940	+ 6
Oil	1,271	1,242	1,241	14,813	13,921	+ 6
Gas	269	295	221	2,913	2,595	+12
Dry	582	581	585	6,627	6,424	+ 3
Per cent dry	27.4	27.4	28.6	27.2	28.0	— 0.8
Wildcat wells	411	399	300	4,303	4,105	+ 5
Oil	44	41	31	597	541	+10
Gas	13	13	7	125	130	— 4
Dry	354	345	255	3,581	3,434	+ 4
Per cent dry	86.1	86.5	85.0	83.2	83.7	— 0.5
Crude production	145,800	¶143,400	138,495	1,731,479	1,711,103	+ 1
Daily average	4,703	4,780	4,468	4,744	4,688	
Crude demand‡	153,700	144,700	146,270	1,808,431	1,788,709	+ 1
Daily average	4,958	4,823	4,718	4,955	4,901	
Crude stocks	231,610	¶233,210	223,259	231 610	223,259	+ 4
Days supply	47	48	47	47	47	
Natural gasoline production	10,240	¶9,793	9,631	114,680	111,274	+ 3
Daily average	330	326	311	314	305	
Motor fuel production	68,300	¶65,300	66,058	774,554	799,059	— 3
Daily average	2,203	2,177	2,131	2,122	2,189	
Gasoline yield, per cent	40.7	¶40.9	41.2	39.5	40.9	— 1.4
Motor fuel demand‡	62,160	¶63,080	54,792	775,936	785,257	— 1
Daily average	2,005	2,103	1,767	2,126	2,151	
Motor fuel stocks	92,300	¶86,160	93,682	92,300	93,682	— 1
Days supply	45	41	53	45	53	
Fuel oil production	60,000	55,300	59,785	716,897	718,716	0
Daily average	1,935	1,843	1,928	1,964	1,969	
Fuel oil demand‡	77,800	62,400	77,286	750,770	794,581	— 6
Daily average	2,510	2,080	2,493	2,057	2,177	
Fuel oil stocks	109,900	122,200	72,936	109,900	72,936	+51
Days supply	45	60	29	45	29	
Refinery still runs	147,760	140,700	141,779	1,729,972	1,719,534	+ 1
Daily average	4,766	4,690	4,574	4,740	4,711	
All refined stocks†	287,000	¶296,000	240,320	287,000	240,320	+19
Days supply	51	57	47	51	47	

Economic Position of U. S. Petroleum Industry

Twelve Months Ending December 31, 1946

	Normal	Actual	Per cent of normal
Drilling*** (wells completed)	30,000	28,656	96
Production (daily crude output)	4,721	4,744	100
Refining (daily still runs)	4,700	4,740	101
Stocks (crude and refined)†	490,025	518,610	106
Price of crude (per bbl.)	$1.88**	$1.64	87

Crude Prices by States for December, 1946

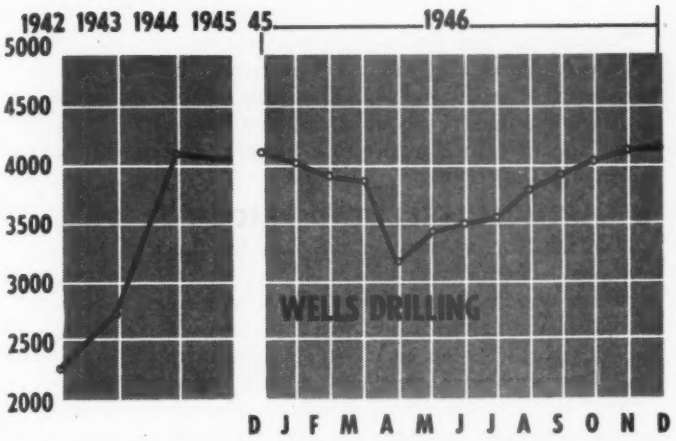
U. S. average	$1.64	Louisiana	$1.67	**Basic crude prices**	
Texas	1.66	Arkansas	1.48	Oklahoma-Kansas (36 gr.)	$1.62
California	1.41	New Mexico	1.45	Texas Gulf Coast (36 gr.)	1.85
Oklahoma	1.68	Mississippi	1.47	East Texas	1.70
Kansas	1.67	Illinois	1.84	West Texas (36 gr.)	1.49
		Other states	2.28	Calif. Signal Hill (26 gr.)	1.46
				Pennsylvania, Bradford	3.10

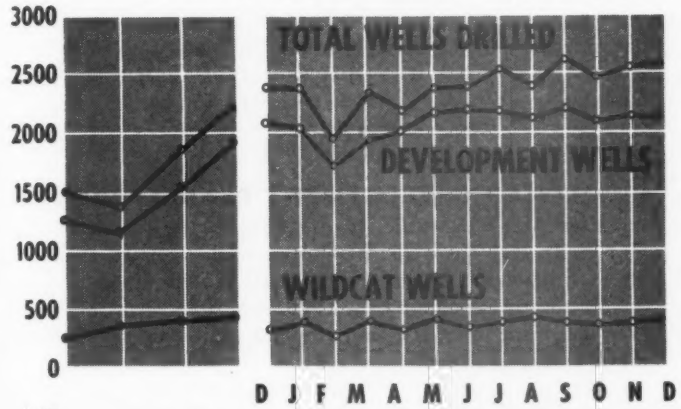
Drilling and Production Statistics by States

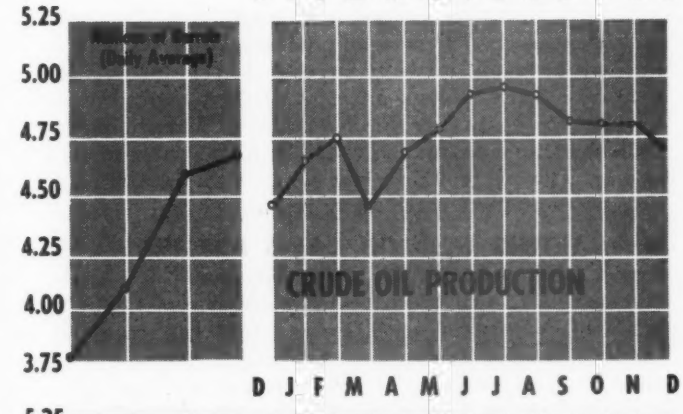
	Dec. 1946(p)	Nov. 1946(p)	Dec 1945	This year to date	Last year to date	Per cent change
Total wells drilled	2,533	2,517	2,347	¶28,656	27,045	+ 6
Texas	648	615	645	7,857	7,250	+ 8
California	111	¶165	146	1,739	2,194	—21
Oklahoma	319	374	237	3,059	2,445	+25
Kansas	233	187	191	2,019	1,796	+12
Louisiana	116	143	121	1,410	1,167	+21
Arkansas	19	17	23	195	181	+ 8
New Mexico	43	31	38	415	415	0
Mississippi	42	28	18	270	359	—25
Illinois	216	186	153	2,351	1,802	+30
Other states	784	¶771	775	9,341	9,436	— 1
Wildcats drilled	411	399	300	4,303	4,105	+ 5
Texas	139	119	125	1,582	1,567	+ 1
California	33	24	16	260	240	+ 8
Oklahoma	88	84	42	593	460	+29
Kansas	24	45	20	308	371	—17
Louisiana	18	21	15	249	172	+45
Arkansas	9	5	8	47	45	+ 4
New Mexico	2	3	5	43	82	—48
Mississippi	16	8	4	84	125	—33
Illinois	34	45	19	504	363	+39
Other states	48	45	46	633	680	— 7
Daily crude production	4,703	4,780	4,468	4,744	4,688	+ 1
Texas	2,002	¶2,090	1,933	2,079	2,070	0
California	871	¶863	842	862	894	— 4
Oklahoma	369	358	382	369	378	— 2
Kansas	276	274	238	267	263	+ 2
L uisiana	418	413	365	393	358	+10
Arkansas	78	77	77	77	78	— 1
New Mexico	106	103	95	101	102	— 1
Mississippi	83	79	53	66	51	+29
Illinois	202	205	208	207	206	0
Other states	298	¶318	275	323	288	+12

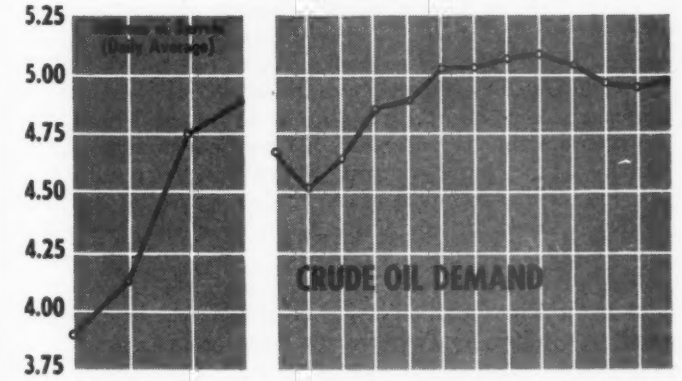
*Unless otherwise stated all figures represent thousands of barrels.
‡Total demand, including exports.
¶Revised.
***Does not include input wells.
**Price 1926 (Index 100)
(p) Preliminary
†Includes natural gasoline stocks.

PRELIMINARY ESTIMATES BASED UPON DATA FURNISHED BY AMERICAN PETROLEUM INSTITUTE, U. S. BUREAU OF MINES, STATE AGENCIES AND OTHER OFFICIAL SOURCES.

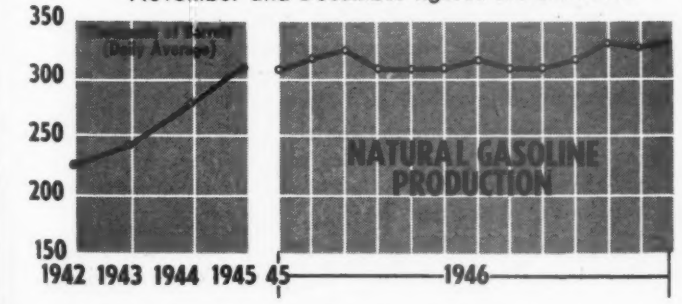


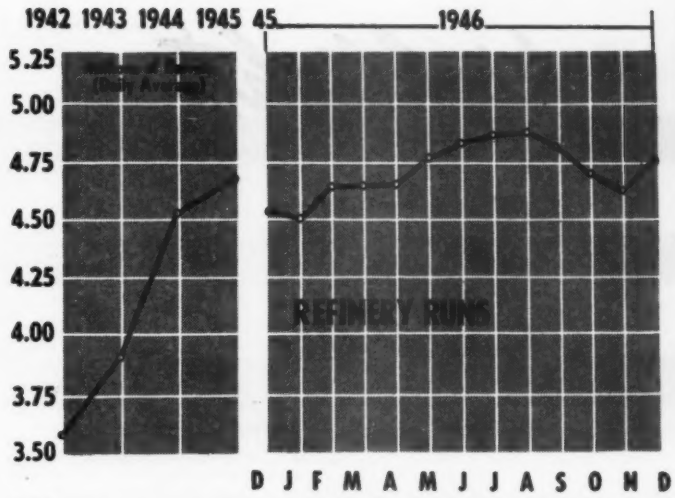


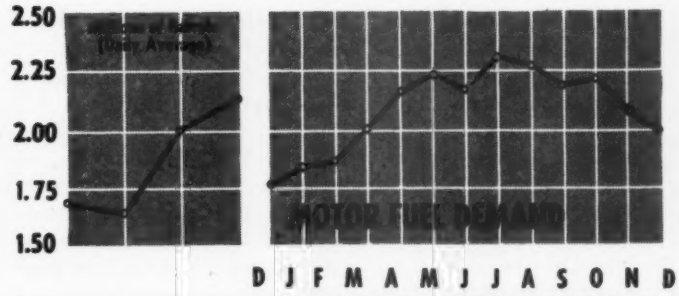


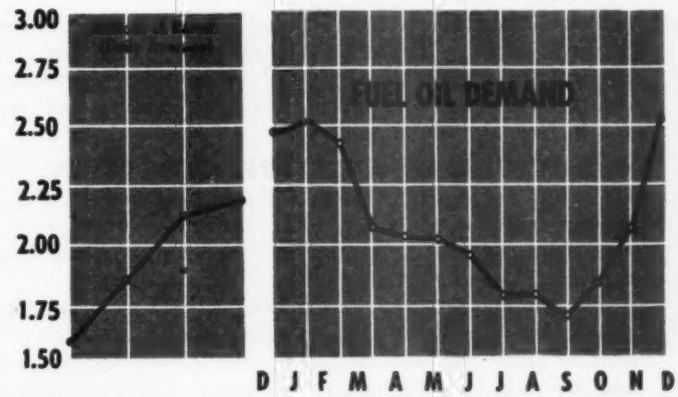


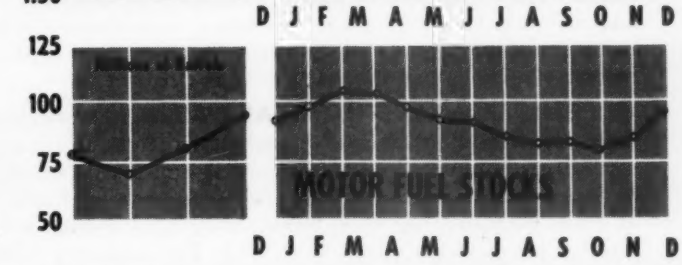
November and December figures are estimates.

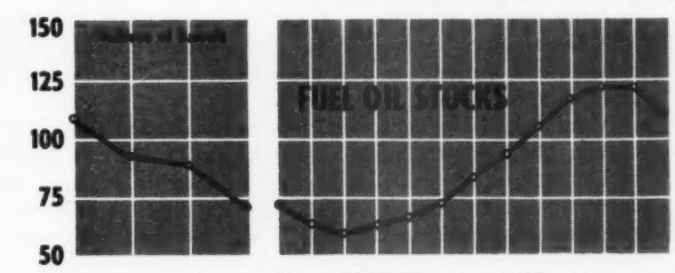




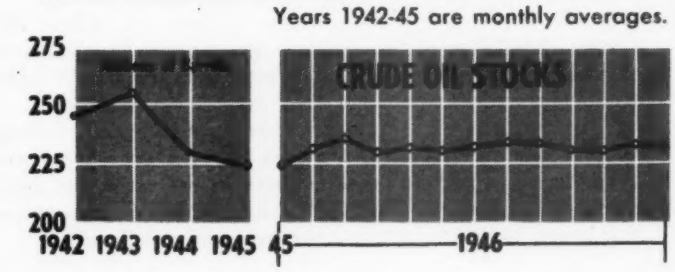




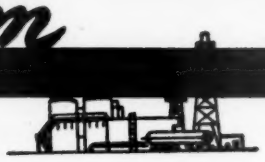




Years 1942-45 are monthly averages.



highlights in oildom



● **U. S. FIRMS DEAL FOR MIDDLE EAST OIL.** Two U. S. firms—Standard Oil Company (New Jersey) and Socony-Vacuum Oil Company, Inc., have announced in "principle" two big deals to obtain oil from the Middle East. It is disclosed that a "preliminary" agreement has been reached whereby the Arabian-American Oil Company, which owns exclusive rights to the Saudi Arabian fields, would sell about 30 per cent of its holdings to Standard of Jersey and about 10 per cent to Socony-Vacuum. The Arabian-American Oil Company is controlled by Standard Oil Company of California and The Texas Company.

In the second agreement, Standard of New Jersey and Socony-Vacuum reached an accord in principle with the Anglo-Iranian Oil Company, Ltd., to purchase substantial quantities of crude oil from this British company, which operates in Iran.

● **MAY DISMISS ANTI-TRUST LITIGATION.** The U. S. Justice Department at Washington has announced that its anti-trust division has recommended dismissal of the six-year-old anti-trust suit against the American Petroleum Institute and 200-odd oil companies.

The suit, filed in 1940, charged the API, 22 major oil companies, and more than 200 subsidiaries with conspiracy to restrain trade, monopolize the industry, manipulate prices, and maintain other practices detrimental to consumers. The case was not prosecuted during the war, but the justice department revived it last spring.

● **PETROLEUM AND NATURAL GAS.** New production records were established in all branches of the petroleum and natural gas industries in 1946, according to a report released by Secretary of the Interior J. A. Krug. The record production of crude petroleum in 1946, estimated at 1731 million bbl., was 1.2 per cent greater than in 1945. The estimated value of crude petroleum at the well was $2,440,000,000, including subsidies for stripper wells. This total value represents an increase in the average value at the well from $1.22 per bbl. in 1945 to $1.41 per bbl. in 1946.

Total demand for all oils in 1946 is estimated at about 1927 million bbl. compared with 1952 million in 1945, a decline of about 1.3 per cent. All this decline was in exports, and domestic demand may have exceeded that in 1945. The most notable factor in domestic demand was the large civilian consumption of motor fuel, particularly for automotive use.

Stocks of all oils probably increased about 55 million bbl. during 1946. Part of this increase was a normal replacement of depleted stocks, but the total increase indicates that primary production and imports materially exceeded requirements.

The marketed production of natural gas increased to about 4040 billion cu. ft. in 1946, a gain of 4 per cent over 1945 characterized by continued increases in domestic and commercial consumption. The total value at points of consumption was about $835,000,000 in 1946, according to Krug.

Natural gasoline and cycling plants extracted about 4836 million gal. of liquid products from natural gas in 1946, or 3 per cent more than in 1945. The value of all products at the plants amounted to about $186,000,000 in 1946, slightly below the 1945 total owing to lower prices received until the late months of 1946.

● **MINIMUM WELLHEAD PRICE FOR GAS.** The Oklahoma Corporation Commission has fixed a minimum price of 7 cents per thousand cubic feet for gas at the wellhead in the Guymon-Hugoton field. The commission, in its order, held that the evidence presented at a hearing indicated that producing gas for less than 7 cents (present price is 4 cents) would constitute economic and physical waste.

The action, which already has been appealed by Cities Service Gas Company, is certain to have far-reaching effect in all producing and consuming centers. It establishes a precedent that may prove to be the most important contribution to conservation of gas since its consumption attained a national scale. It may also provide the action necessary for higher prices in other Southwestern producing areas, a movement that so far has failed to obtain much results.

● **BOLIVIAN DEVELOPMENT PLAN APPROVED.** Guillermo Mariace Muniz, manager of the Bolivian government-controlled oil wells, has announced officially that the Export-Import Bank had advised "that it is disposed to concede an additional credit of $3,000,000 to be used on a plan of well-drilling and the construction of a pipe line from Camiri to Cochabama."

Within the project, the $5,500,000 plan of the Bolivian oil well development corporation will be amplified. The loan will permit the use in Bolivia of oil produced in Bolivia as the pipe line will carry oil to two refineries in Cochabama and Surce. Rene Ballivian Calderon, president of the oil operations, said construction of the pipe line and refineries, and drilling of the wells to increase production would be completed in mid-1948, at which time it would be possible to serve the full needs of Bolivian consumption for many years.

● **DRAFTING NEW OIL LAWS FOR PERU.** New oil laws are being drafted for Peru that should accelerate the development of that country's natural resources. Oil has been produced in Peru for some 30 years, but the growth of the industry has lagged behind that of neighboring countries because of inadequate laws. American capital, apparently, is ready to venture large-scale expenditures to develop oil in Peru as soon as adequate laws have been provided to safeguard its investment. The government of Peru, on the other hand, would like to have foreign capital develop this natural resource, and consequently is having its oil laws revamped. The work of drafting the new laws has been entrusted to A. A. Curtice, of the New York firm of Hoover, Curtice and Ruby, Inc. He acted as technical adviser, together with his associate, Herbert Hoover, Jr., in drafting the Venezuelan petroleum laws of 1943.

The bill drafted for Peru is drawn along the same general lines as the Venezuelan oil laws, but with numerous modifications to conform to Peruvian traditions and economic conditions.

Special legislation is necessary because the Peruvian government owns all the sub-soil rights. Neither foreign capitalists nor, for that matter, domestic interests can acquire title to those sub-soil rights, either by outright purchase or by privately arranged leaseholds, as is done in the United States.

The established custom is for the national government to grant oil concessions on a royalty basis, with payments accruing to that government. The laws define the terms under which concessions may be granted.

The projected legislation is presently in the hands of a committee of the Peruvian house of deputies for recommendations.

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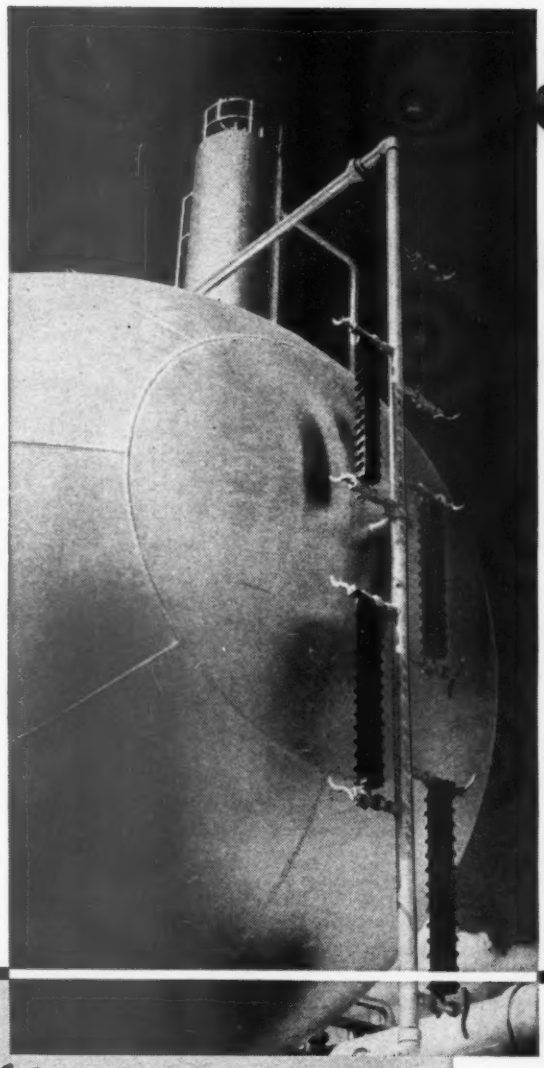

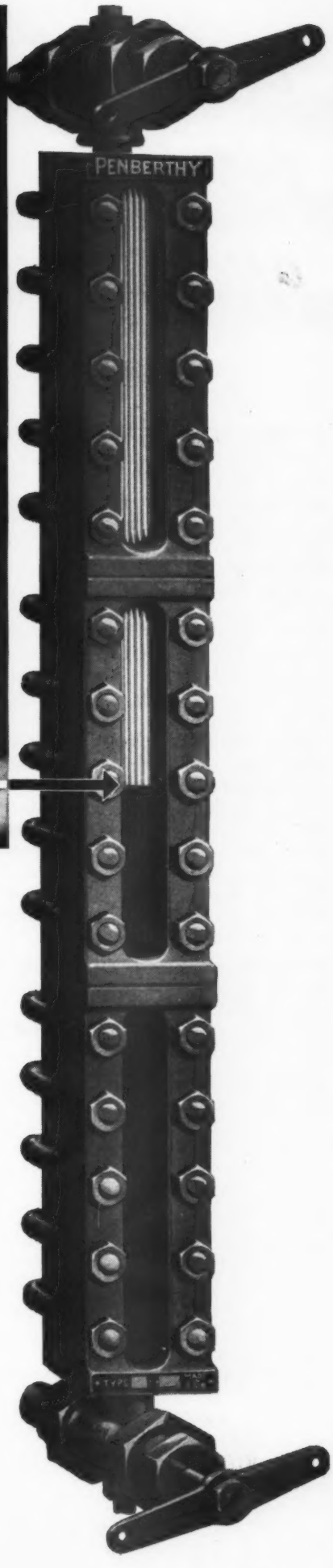

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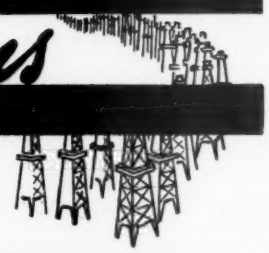
current oil field operations



● **OKLAHOMA.** The Bay Petroleum Corporation No. 1 Follandsbie, a wildcat in SW SE SW 16-13-8e, to the southwest of Micawber area, Okfuskee County, looks like a new pool opener. The test had the Dutcher sand at 3565 ft. and took a drillstem test at 3565 to 3575 ft. Open 15 minutes it sprayed gas and oil and when the test ended there was 500 ft. of oil in the tester.

H. A. Taylor and associates may have a new pool for Cotton County at No. 1 J. L. Taylor, SW SE SW 34-3s-11w, about a mile and a half northwest of Cache Creek field. Sand was found at 1445-48 ft., and on drillstem there was recovered 250 ft. of clean oil and some mud.

R. Olsen and others No. 1 Ott, CWL SW SE 4-21n-9w, Major County, appears to be a new pool opener. An official report stated that the drillstem test taken from 8015 to 8124 ft. showed 70 ft. of 54 gravity condensate in the hole.

Plymouth Oil No. 1 Gibson, SW SE SW 14-5n-4w, has opened the third producing sand in the North Lindsay area, McClain County. With Hunton topped at 10,151 ft., the well flowed 140 bbl. of oil in 24 hr. Total depth was 11,557 ft., with casing set at 11,460 ft. Production in the deep pool is from the Bromide, but Frank Russell's No. 1 Ed Little, NE NW NE 22-5n-4w, was completed for an oiler in the Viola at 10,734 to 10,806 ft.

● **ILLINOIS.** Sohio Petroleum Company No. 1 L. Bosserman, NE SE SE 5-5s-3e, Franklin County, after a one-hour drillstem test showed gas in 50 minutes, 1060 ft. of clean oil, 40 ft. of oil-cut mud, and 30 ft. of drilling fluid. Total depth of hole is at 2841 but electric log did not get below 2833 ft.

● **NEW MEXICO.** Prospects for opening the first Dakota production inside the San Juan Basin of Northwest New Mexico were indicated at Byrd-Frost No. 1 Federal-Hargrove, 4-27n-10w. Hole is bottomed at 6492 ft. in sand. A core at 6481-92 ft. is credited with returning 7 ft. of sand bleeding condensate. Heretofore, Dakota production has been found on the edges of the basin.

● **KANSAS.** Continental Oil Company No. 1 Smith, NW NW NW 21-33-12w, Barber County, southeast of Skelly Oil Company new Boggs oil pool, has established a potential of 1405 bbl. of oil daily from the Simpson sand.

Skelly Oil Company No. 1 Allen, SE SE SW 22-11-9w, Ellis County, some 10 miles southwest of the Mortgage strike, has established commercial production from the Arbuckle.

Plains Exploration Company No. 1 Swander, SW-SE-SW 20-28-9w, some 11 miles southeast of the Cunningham oil and gas pool, Kingman County, is showing for a big flowing well from the Viola lime. Estimates on production range from 1000 bbl. daily upward.

Continental No. 1 Mortgage, SE NE NE, 3-11-8w, 1½ miles west of the north edge of the Burnett pool, Ellis County, is showing big production from the Arbuckle.

● **LOUISIANA.** A potential strike is Stanolind No. 1 Guillory, 29-6s-2e, which perforated from 8952-958 ft. and on a drillstem test flowed an ungauged amount of gas and condensate. Operators were running tubing. The location is two miles northeast of the Bayou Mallet pool, St. Landry Parish.

A pool was indicated in Humble No. 1 Romaine, 25-12s-1e, Vermilion Parish, which was perforated from 11,065-71 ft. and on initial test flowed 102 bbl. of oil and a like amount of salt water. Operators squeezed for a second test.

Stanolind also opened a new and deeper producing zone for the South Jennings pool of Jeff Davis Parish at No. 8 South Jennings, which gauged 44.64 bbl. of condensate daily through choke from perforations at 10,925-936 ft.

● **TEXAS.** Rogers Lacy No. 1 Fee, Llano Grande grant, wildcat northeast of Mercedes in Hidalgo County, has possibilities of a dual completion from a gas-condensate sand near 7450 ft. and oil sand at 7850-60 ft. Another sand at 7983-92 ft. showed crude on drillstem test, but salt water developed. Casing is set near 8000 ft.

Gulf Oil Corporation No. 99-E Keystone in Winkler County, C NE SE 10-B3-PSL, flowed 1145 bbl. of 41.2 gravity oil on an 11-hr. drillstem test of the upper Clear Fork from 5131-51 ft. Deepened, it rated 907 bbl. daily on a test from 5050-65. The strike is a west offset to a Keystone Ellenburger producer. A number of nearby wells showed porosity in the upper Clear Fork but developed sulphur water and no oil.

No. 1 Crittenden estate, northeast of lot 26, league 335 of the Louise Kratz survey, had the Flippen sand at 2617-42 ft., total depth, and pumped 150 bbl. of oil a day. Walter K. and Byron W. Jones (father and son) opened the Jones County field.

Completed for a 24-hr. natural flow of 168 bbl. of pipeline oil, Sun Oil Company No. 1 Allen Jameson, Strawn discovery in northwestern Coke County, C SE SW 253-1A-H&TC, was given a daily allowable of 140 bbl. pending a hearing.

A new and deeper producing horizon for the Nada pool of Colorado County has been opened by Ohio Oil Company No. 1-A Nada Unit, Indianola Railroad Company survey, Section 24. Drilled to 10,332 ft. and perforated from 9910 to 9916 ft. for production test, the well flowed gas and condensate along with some water and has been shut in for erection of tanks and flow lines.

● **WYOMING.** Wyoming has a new Tensleep deep-horizon oil field. It is the Quealy field of Albany County, northwest of Laramie. The California Company, subsidiary of Standard Oil Company of California brought in the new well, No. 2 Holst, NE SE 13-17n-77w. It was deepened from an old total depth of 4207 ft. to its present depth of 5643. On drillstem test of the upper Tensleep sand, 3400 ft. of black oil of about 33 gravity was recovered.

Oil men said the discovery probably would result in the deepening of practically every Wyoming oil field that has good closure and that now is producing from shallow beds.

● **VENEZUELA.** Pantepec Oil Company of Venezuela, C. A., announced that Tucupido Well No. 1, being drilled by Atlantic Refining Company under its contract with Pantepec, promises existence of an entirely new oil field in Venezuela. The well produced at the rate of 257 bbl. of oil per day on an 8½-hr. test through a ¼-in. choke, and at the rate of 432 bbl. on a 5½-hr. test through a ⅜-in. choke. The oil, of 40.8 degrees gravity, showed no water.

Tucupido is about 75 miles west of the Roble field belonging to Pantepec and Creole Petroleum Corporation, and approximately 35 miles northeast of the Mercedes field owned by Texas Company and Caracas Petroleum Company. The tract on which the well is situated comprises 35,000 acres.

The new well is in an area distinct and distant from the Pelayo concession, jointly owned by Pantepec and Atlantic Refining, on which Pelayo Well No. 1 was recently brought in.

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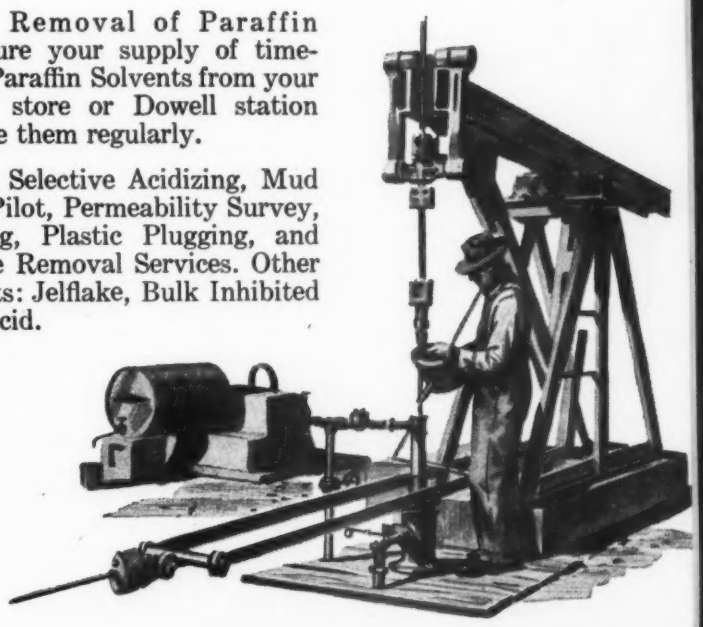
Ask for your free copy of the interesting illustrated handbook—"Time Proven Methods for Removal of Paraffin Deposits." Secure your supply of time-tested Dowell Paraffin Solvents from your nearest supply store or Dowell station right away—use them regularly.

Ask also about Selective Acidizing, Mud Acid, Electric Pilot, Permeability Survey, Water Locating, Plastic Plugging, and Industrial Scale Removal Services. Other Dowell Products: Jelflake, Bulk Inhibited Hydrochloric Acid.



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Look to

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pipeline developments

● **ASK FOR NEW INCH LINE BIDS.** The War Assets Administration has called for new bids for purchase of the Big and Little Big Inch pipelines as natural gas or petroleum conveyors. WAA set noon, February 8, as the deadline for submission of bids. Bids will be opened February 10.

The lines, built during the war at a cost of $147,000,000, were leased shortly after the start of the recent coal strike to Tennessee Gas and Transmission Company for transportation of natural gas. That lease will remain in force until April.

Bids for the purchase of the lines were asked once before. WAA Administrator Robert M. Littlejohn announced on November 19 that all bids received then had been rejected because he believed that none guaranteed a "fair price" to the government. He fixed that price as at least $113,700,000.

● **PLANS NEW BIG INCH.** Trans-Continental Gas Pipe Line Company, Inc., has petitioned FPC for authorization to build a $130,000,000 natural gas pipe line from Texas to the eastern seaboard.

The application says Trans-Continental, with headquarters at Longview, plans a 26-in. main line extending from Hemphill, Sabine County, Texas, a distance of 1380 miles, and serving outlets in New York, Pennsylvania, New Jersey, Delaware, and Maryland.

● **BUY TANKERS.** Pan American Petroleum and Transport Company, a subsidiary of Standard Oil Company (Indiana), will purchase two T-2 type tankers from the United States Maritime Commission for a total of $3,550,000.

Tide Water Associated Oil Company will purchase five tankers of the T2-Se-A1 type from the United States maritime commission. The tankers will cost $10,132,500, subject to adjustment under the merchant ship sales act. Acquisition of the ships will bring Tide Water's fleet to 14 vessels totaling 191,000 tons all of which are used in the Atlantic coast-Gulf trade. The new tankers with a tonnage of about 82,500 tons, with a speed of about 15 knots, will have about the same carrying capacity as five tankers lost by the company in the war, plus old tankers to be withdrawn from service.

● **SETTLE BUYERS' DISPUTE.** The Russian government was denied the right to take over a contract that the U. S. Treasury held with the A. O. Smith Corporation, Milwaukee, Wisconsin, for 183 miles of large diameter steel line pipe.

The decision, rendered in the United States district court of western Texas, Judge C. A. Boynton presiding, ended a litigation begun when charges were made that the efforts of the Russians would seriously interfere with the supply of natural gas to more than a million residents of Southern California.

The decision came as the result of a stipulation presented to the court by A. O. Smith and five other large domestic companies whose interests were involved. The stipulation set forth a plan for the allotment of Smith's production of pipe that was satisfactory to the companies. In addition, A. O. Smith asked the court to rule on whether Russia had a legal right to step in. The court approved the stipulation, and ruled that Russia had no rights in the matter.

The stipulation further provided that any purchaser could procure pipe from A. O. Smith outside the agreed allotments if the purchaser could provide the steel, and if A. O. Smith's pipe mill were not operating at capacity.

The decision ended a court action which began in October after Governor Warren of California, in a telegram to the State Department, charged that A. O. Smith had given preferential position to an order for pipe which he claimed was placed by the Russian government. He asserted that the filling of the order would delay construction by the El Paso Natural Gas Company of a pipe line of nearly 1000 miles from Texas to Southern California and would work great harm on the residents of that area.

A. O. Smith promptly answered that it had no order from the Russian government. It said that it did have an order from the United States Treasury Department for 183 miles of pipe, that the treasury order had been placed before the El Paso order and that A. O. Smith had no choice but to fill it first. The Treasury Department had placed the order for the UNRRA and it in turn planned delivery of the pipe to the Ukraine district of the USSR.

Under the stipulation, the El Paso Company is to get 341 miles of its original Smith order, and by procuring its own steel, it hopes to complete its Texas-California line by utilizing available capacity of the A. O. Smith mill.

● **MEXICAN LINE IN WORK.** Construction of a new natural gas pipe line to bring fuel from the lower Rio Grande Valley of Texas to Monterrey is due to begin immediately, Feliciano Elizondo, Mexican capitalist, has announced. Elizondo is president of the company already operating one pipe line between Roma, Texas, and Monterrey, carrying more than 30,000,000 cu. ft. of gas daily. The second line will have greater capacity, carrying up to 80,000,000 cu. ft. daily.

Clint W. Murchison and associates of Dallas own 45 per cent of the pipe line company. The new 12-in. line will cost approximately $4,000,000.

● **TEXAS LINE.** Construction of a $1,240,000 six-inch pipe line over the 100 mile route from Sheridan to Houston will begin in February, Shell Pipe Line Corporation has announced. The line will run from the company's cycling plant to its refinery near Houston.

● **FPC APPROVES $200,000,000 IN PROJECTS.** New construction and operation authorizations expected to make available to 71 large cities and many smaller communities an additional volume of more than a billion cubic feet of natural gas daily have been approved by the Federal Power Commission within recent months, Chairman Leland Olds announced. Value of the facilities is estimated at $193,576,544.

Many communities urgently needing additional supplies of natural gas to meet rapidly expanding demand for home heating will benefit as results of issuance by the FPC between July 1, 1945, and September 30, 1946, of 90 certificates of public convenience and necessity for construction and operation of natural gas transportation facilities. The new construction was planned for 18 states and was intended to add at least 1,106,000,000 cu. ft. of natural gas daily to the aggregate supply of several score of communities in many parts of the country.

The unprecedented demand for natural gas has been attributed to the increasing availability of gas-fired house heating units following the end of war restrictions and to the activity of the Federal Power Commission in bringing about reductions in the wholesale rates of natural gas supplied by interstate pipe line companies.

Projects covered by certificates issued during the 14-month period involve construction of 4465 miles of new gas pipe lines and new installation of 276,535 compressor horsepower.

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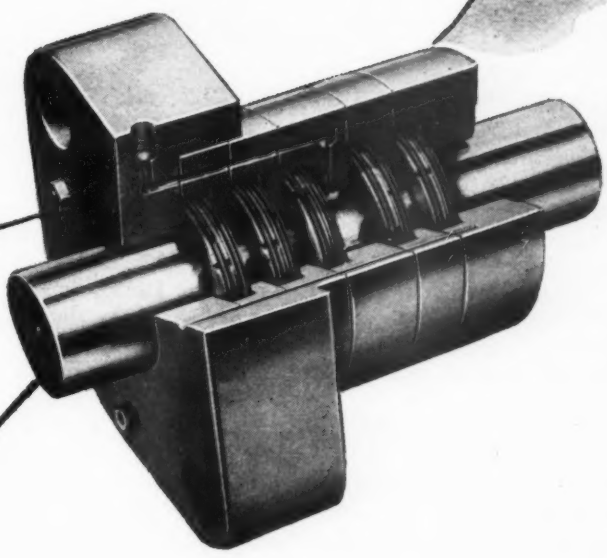

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refining and natural gasoline activities

● **STANOLIND PLANS SYNTHETIC OIL PLANT.** The Stanolind Oil and Gas Company is currently considering the desirability of constructing a large commercial-scale Synthol plant in the Mid-Continent area for the synthesis of oil from natural gas. Tentative plans are for the plant to be constructed in southwestern Kansas in the huge Hugoton gas field, which has total estimated reserves of 23 trillion cubic feet and is the largest gas field in the United States. About 100,000,000 cu. ft. per day of gas will be processed, yielding approximately 6000 bbl. per day of high-quality gasoline and 1000 bbl. of distillate fuels. Engineering of the plant is now in progress.

The Hugoton plant is being designed to process low-heating-value gas currently unsuited for sale as fuel gas. An extensive pipe line gathering system and a natural gasoline plant would be installed to provide the necessary volume of dry feed gas. In the process the feed gas is burned under 300 pounds pressure with relatively pure oxygen to yield synthesis gas with a composition controlled to within narrow limits. Oxygen for use in this step would be produced by fractionating liquid air in the largest plant ever constructed for this purpose. For each 15,000 cu. ft. of gas charged to the plant, one barrel of crude synthetic oil and substantial amounts of oxygenated compounds (including alcohols, ketones, aldehydes, and acids) are produced. The recovery and treatment of the hydrocarbon products for market would be accomplished by conventional refinery methods. Consideration is being given to the installation of a pipe line to transport finished gasoline and distillate fuels to markets in Kansas. The synthesis reaction itself is carried on under pressure in large "fluid" type reactors utilizing a special powdered iron catalyst.

One step of the Synthol process is based on the German "Fischer-Tropsch" synthesis principle, whereby a gaseous mixture of carbon monoxide and hydrogen is passed over a catalyst under suitable conditions of temperature and pressure to yield hydrocarbons in the liquid fuel range. The process, as applied industrially by the Germans, utilized coal as the raw material for preparing carbon monoxide and hydrogen, which were thereafter synthesized to hydrocarbon and chemical products.

● **CONTRACT FOR SYNTHETIC UNIT.** Arthur G. McKee and Company, Engineers and Contractors, Cleveland, announce completion of contract agreement with Carthage Hydrocol, Inc., New York, as engineers and contractors for the construction of a plant for Carthage at Brownsville, Texas, for the manufacture of synthetic petroleum products and chemicals from natural gas. The plant will utilize the Hydrocol process developed by Hydrocarbon Research, Inc., New York, which company is supplying the basic designs for the building of the plant. The estimated cost of the plant is approximately $16,000,000.

● **HOUDRY UNIT TO BE ADDED.** Reid Brasell, president of Leonard Refineries, Inc., Alma, Michigan, has announced further expansion plans including revamping of existing refinery facilities in connection with the construction of the first postwar small scale Houdry thermofor catalytic cracker. Simultaneously, he has stated that the contract for this work has been awarded to Catalytic Construction Company.

The expansion includes the revamping of the feed-preparation and fractionating sections to tie in with the new TCC unit. The new construction work involves an additional expenditure of $150,000.

T. Ellwood Webster, president of Catalytic Construction Company, reports progress in construction of the unit to date. "The erection of the steel structure, kiln, and reactor of the TCC unit is completed," Webster said. "As previously announced, the construction of the TCC unit will be completed in January, 1947, and the revamp work finished early in February."

● **CYCLING PLANTS IN CONSTRUCTION.** The California Corporation has under construction a cycling plant with a throughput of 100,000,000 cu. ft. per day at Lake St. John, Tensas Parish, Louisiana. It will combine cycling operations with facilities for processing solution gas. This plant is expected to be in operation in March. The same company also has under construction a similar plant in the Cranfield oil field, Adams County, Mississippi, which will be completed the middle of 1947. Both plants are being constructed by the Hudson Engineering Corporation.

● **McCARTHY TO BUILD UNIT.** The McCarthy Chemical Company plans immediately construction of a chemical plant at Winnie, Chambers County, Texas, Glenn H. McCarthy, president, has announced. The first unit will cost more than $3,000,000. The plant will be used for the production of unsaturated hydrocarbon chemicals, including benzine and styrene.

Winnie was selected as the site because McCarthy's refinery and natural gasoline plants are situated there. An official of the company said that this is the first of several units planned for processing petroleum and natural gas.

● **PHILLIPS BUYS UNIT.** Sale of Danciger Oil and Refining Company's 7500 bbl. per day refinery at Pampa, Texas, together with the company's gas and crude oil gathering lines in Gray County, to Phillips Petroleum Company has been announced. Consideration was understood to be $1,500,000. The Pampa refinery has been shut down for several weeks.

Danciger's natural gasoline plant at Lefors, about 12 miles from the refinery, was not sold, but will be moved later, when a new location is decided upon.

● **TO MAKE CATALYST CHANGE.** Contract has been awarded by Socony-Vacuum Oil Company, Inc., to Catalytic Construction Company for catalyst change in its six-case Houdry fixed bed unit at Paulsboro, New Jersey. Contract for the work was based on a fixed price quoted by Catalytic Construction Company. Work is already begun and it is estimated that it will be completed in six weeks.

● **BRITISH TO PUSH REFINING.** Imperial Chemical Industries, Ltd., Britain's £74,000,000 (about $296,000,000) chemical enterprise, has decided to begin manufacturing petroleum by-products for the use of the plastics and other industries in a big way, it was learned in London. A new division of oil technology is contemplated, comparable in size and scope to the company's older divisions, such as alkalis, dyestuffs, fertilizers, and explosives. The new enterprise will be entirely separate from the Billingham plant for the extraction of oil from coal, which will be small in comparison.

Imperial Chemical disclosed that it will spend some £3,350,000 (about $13,400,000) for research this year. The field of petroleum technology, previously only touched on, promises big developments within the next two years.

P 427.1

THE Petroleum Engineer

JANUARY, 1947

Diamond coring at Rangely, Colorado

By **ROBERT W. STUART,** *Petroleum Engineer,* Stanolind Oil and Gas Company

THE excessive cost of coring the Weber sand to obtain cores for analysis led to the initial trial of diamond bits in the Rangely field of northwestern Colorado.

EXCLUSIVE

The producing formation (Weber sand) is a section of hard, fine-grained sand cemented with calcite and silica and interbedded with thin stringers of shale and lime. Conventional drilling and coring methods had been improved considerably but were still exceedingly expensive and slow. With additional coring programs as outlined by the Rangely Engineering Committee, it became imperative to try new methods of coring. The use of diamond coring was considered desirable for the following reasons:

1. Thick sandstone sections are suited for diamond bits.

2. 100 per cent core recovery, which is desirable for reservoir analysis, might be obtained with diamond bits.

3. It was thought that the high coring costs in this type of hard sand section could be materially reduced with diamond coring.

The southeast portion of the field was considered most desirable for the initial diamond coring experiments for the following reasons:

1. Only one well had been partially cored in this area, and the core data were inconclusive.

2. The company was obligated to core two more wells in this area under the Rangely Engineering Committee coring program.

3. Coring costs were very high, for this is the hardest and tightest sand section in the field.

4. The company had a considerable number of drilling obligations in this area, and the results of this test might reduce the drilling costs for the remaining wells.

The Mary E. Hefley No. 1 well is approximately in the center of the company's holdings in the southeast portion of the field, and as it was ready to drill into the Weber sandstone with oil base mud, it was chosen for the initial diamond coring test.

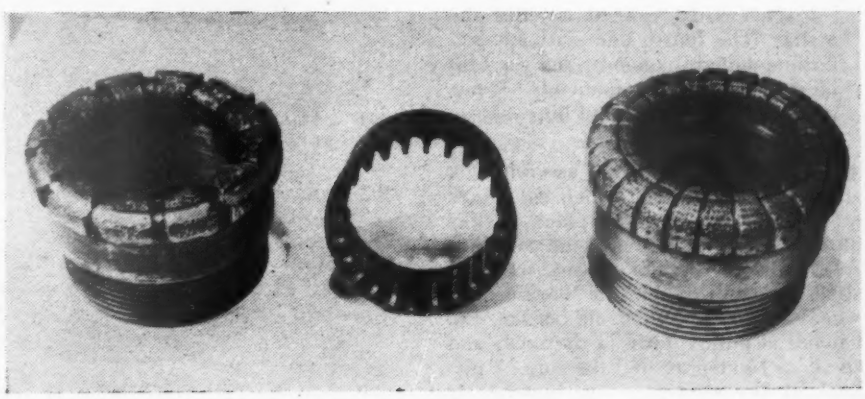
Drilling and Service Ltd. contracted to supply two experimental diamond core bits, a special 25-ft. core barrel, and a supervisor for the initial test at a cost of $6000 with additional diamond bits to be supplied at cost as needed.

● **Oil string set at top of Weber sand.** Mary E. Hefley No. 1 well was spudded on July 9, 1946. Normal drilling operations were used to the top of the Weber sand where 7-in. casing was set at 5655 ft. The diamond core barrel did not arrive in time to begin coring below the casing, so a conventional core barrel and bit was used from 5665 ft. to 5699 ft. At this point the initial run was made with the diamond core barrel and bit (see Charts 1 and 2).

The diamond coring assembly consisted of the following equipment:

1. A 6⅛-in. by 3¾-in. diamond core

FIG. 1. Bit No. 3 (left) shown after 64 ft. with groove gouged out by broken piece of core; Bit No. 4 (right) after 96 ft. with small groove caused by loose diamond. The split-ring tapered core catcher is shown between the bits.



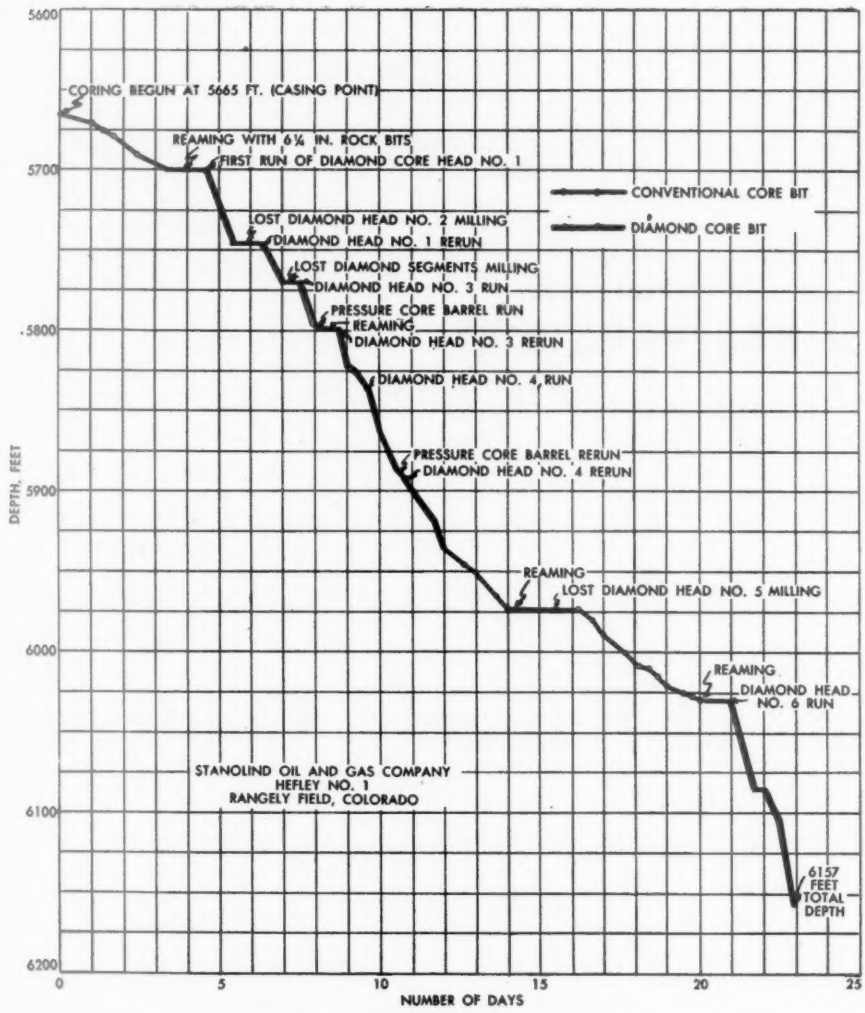


CHART 1. CORING TIME CURVE

bit. Several experimental designs were tried with varying degrees of effectiveness.

The first three bits were made with 12 segments of diamond studded matrix inserted in slots around a chrome-moly steel blank with ½-in. watercourses between the segments. In the first and third bits the diamonds were set flush with the matrix, while the second bit had the diamonds protruding slightly. A picture of the third diamond bit is shown in Fig. 1.

The last three bits were made with two semi-circular molded segments that fitted together around the grooved blank. The bits had 24 ⅛-in. watercourses evenly spaced around the matrix. The fourth and sixth bit had flush-mounted diamonds, and the fifth bit had protruding diamonds. A picture of the sixth diamond bit is shown in Fig. 2.

● **Diamond core barrel assembly.** A slip-ring core catcher, which rides in a tapered section of the bit blank, breaks off the core and holds it in the core barrel. While on bottom coring, the core slides freely through the catcher but when the bit is pulled off bottom, the catcher is pulled down in the taper and the dogs tighten around the core. A picture of the split-ring core catcher is shown between the two diamond bits.

The core barrel assembly includes a 5½-in. by 4¾-in. by 28-ft. outer barrel, and a 4¼-in. by 3¾-in. by 25-ft. inner barrel with a free-floating ball bearing race at the top of the inner barrel. Fig. 3 shows the outer barrel with a diamond bit on the lower end, and Fig. 4 with the inner barrel partly removed shows the ball bearing race. Fig. 5 with the bit removed and the outer barrel pulled up shows a core that has just been recovered.

Three 5-in. drill collars were run on top of the core barrel to give the desired weight and rigidity. Special instruments were installed to aid in controlling the coring operations. A vernier weight indicator was used to check the weight on the diamond bit, a recording pressure gauge was used to record the mud circulation pressure, and a Geolograph recorded the coring rate of the bit.

● **Coring operations on Hefley No. 1.** Coring was begun below the 7-in. casing with a conventional core barrel, and five progressively smaller cutter heads were used to core from 5665 ft. to 5699 ft. The hole was then reamed with two 6¼-in. rock bits, and the diamond core barrel was run. Chart 1 shows the coring operations vs. time on Stanolind's Hefley No. 1 well.

The first diamond core bit cut two cores from 5699 ft. to 5743 ft. under varying operating conditions. Drilling conditions were varied purposely so as to determine the most desirable conditions for diamond coring. The weight on the bit was gradually increased from 2000 lb. to 8000 lb., while the rotary speed was changed from 100 rpm to 150 rpm, and the pump pressure increased from 100 psi to 400 psi. The optimum conditions for diamond coring the Weber sand in this well were found to be 3000 lb. of weight on the bit, 120 rpm rotary speed, and 300 psi pump pressure.

The cores were extracted from the core barrel by removing the diamond bit, sliding the solid cores through a special core holder wrench and breaking them off into a core trough where samples were removed for analysis before the cores were stored. This operation is clearly shown in the accompanying pictures (Figs. 6, 7, and 8).

● **Diamond core head No. 2 broken in hole.** The second bit was run in and set on bottom before rotating. It had protruding diamonds that apparently

FIG. 2. Bit No. 6 after coring 125 ft. and still in good condition.

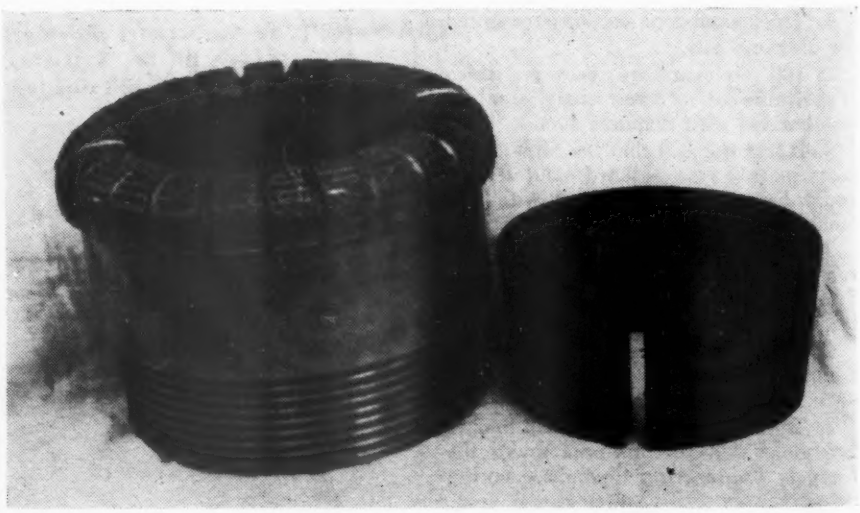
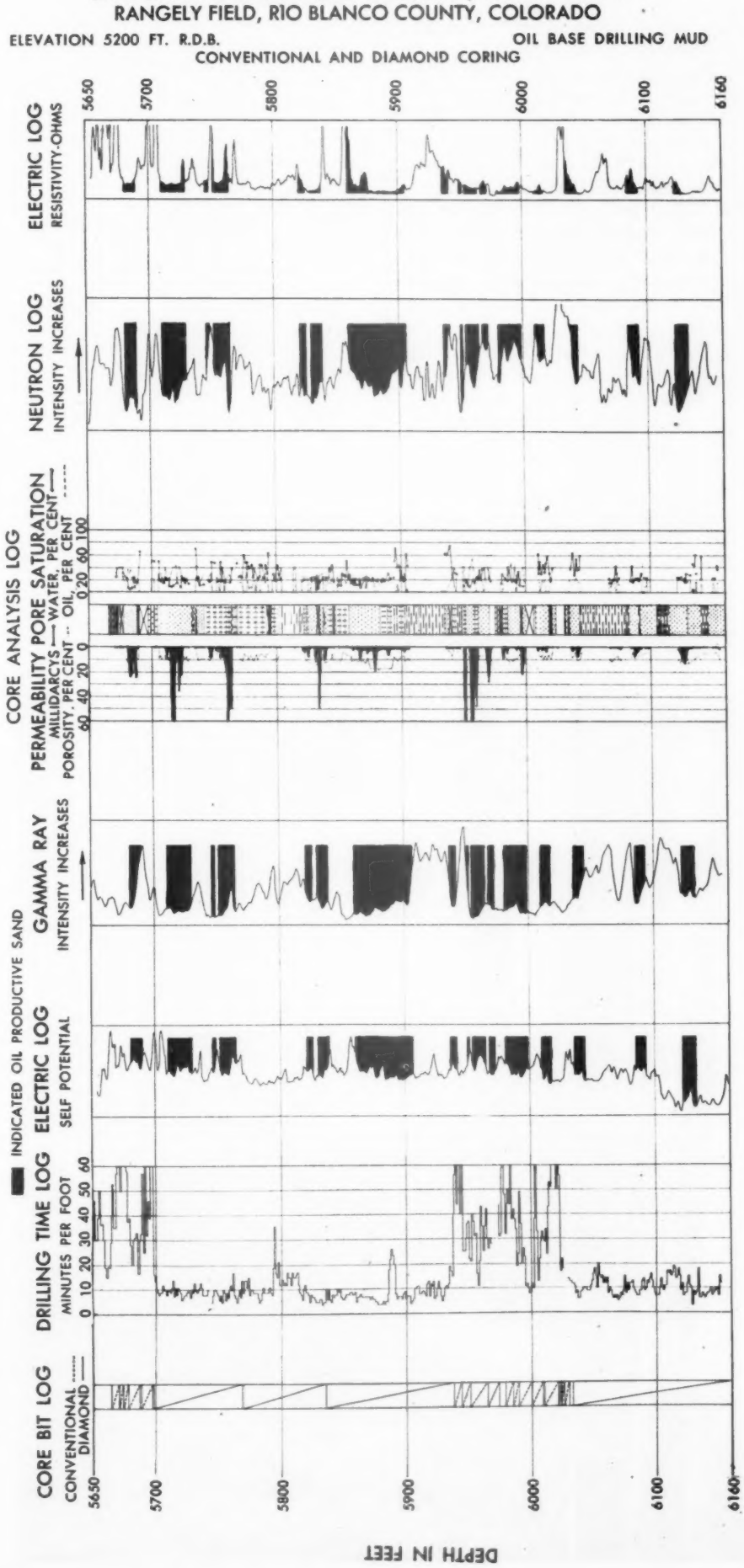


CHART 2. COMPOSITE WELL LOG.



wedged on the bottom and sheared the matrix from the blank when the pipe was rotated. The matrix was milled up with a rock bit, and the large pieces were caught in a junk basket. The diamonds, however, washed out in the mud.

The first bit was rerun and a 25-ft. core to 5769 ft. was cut. While pulling this core, a segment of the matrix dropped out. A 6¼-in. rock bit and basket were then run, and the hole was cleaned out.

The third diamond bit was run from 5769 ft. to 5794 ft. At this point the Carter pressure core barrel was run. After cutting 2 ft., it started binding and was pulled. The third bit was rerun from 5798 ft. to 5835 ft. where a piece of hard core chip gouged the outer edge of the matrix, causing the bit to stop cutting. Fig. 1 shows the gouged diamond bit after it was pulled.

● **Fourth diamond bit cored 96 ft. on two runs.** The fourth diamond bit was run and cored from 5835 ft. to 5885 ft. with very little trouble. The Carter pressure core barrel was rerun from 5885 ft. to 5891 ft., where it was pulled because it began to bind. Fig. 9 shows the diamond core bits used with the pressure core barrel. The fourth bit was rerun and cored from 5891 ft. to 5936 ft. where a diamond pulled out of the matrix and grooved the face of the bit, causing it to stop cutting. Fig. 1 shows the grooved diamond bit after coring 96 ft.

The conventional core barrel was rerun at this point while additional diamond core bits were being shipped. Four cutter heads were run from 5936 to 5973 ft. and the hole was reamed with three 6¼-in. rock bits.

The fifth diamond core bit was run at 5973 ft., and the matrix broke loose from the blank again before it had made any hole. A 6¼-in. rock bit and junk basket were used to clean out the hole.

A conventional core barrel was rerun while waiting on another diamond bit. Ten cutter heads were run from 5973 ft. to 6030 ft., and the hole was reamed at two points with four 6¼-in. rock bits.

The sixth diamond bit cored from 6030 ft. to completion at 6157 ft. and was still in good condition. Fig. 2 shows the sixth diamond core bit after coring 125 ft. and completing the well.

● **Pressure coring operations.** The Carter pressure core barrel was first run at 5794 ft., and, after coring 2 ft., the core barrel began to bind so much that it was pulled. The formation was very hard at this point, and the ball valve on the inner barrel would not close. A core was recovered in the barrel although there was no pressure on it.

A second run was made with the pressure core barrel at 5885 ft., and 6 ft. was cut when the barrel began to bind again, so it was pulled. The ratchet-operated ball valve closed, but it must have leaked, because the 5-ft. core in the inner pressure barrel had only 400 lb. pressure in it when the barrel was tested at the surface.

The cores and the fluids in the pressure core barrel were canned and

shipped to the Carter laboratory where they are being tested. The Stanolind research department has been given representative samples by Carter for independent checking, and Core Laboratories ran a complete analysis on samples at the well. The results of this work should be available in the near future.

● **Composite well log.** A composite well log, comparing all available information on the cored section of the Weber sand, was prepared and is shown in Chart No. 2. This log includes core analysis data, neutron and gamma ray log, contact electrode electric log, drilling time log, and a bit log.

The core analysis data shows the premeable zones. These are shown in black as indicated oil productive sand. The connate water saturation in the permeable zones is much lower than indicated by previous cores. It varies between 10 and 20 per cent of the pore space. The various logs have been correlated with the permeable zones shown by the core data, and are shown in black at these points.

The neutron and gamma ray logs seem to give good correlation with the core analysis log in the oil base mud in this well. The gamma ray log indicates definite formational breaks that check the sand, shale, and lime sections on the core log. The neutron log indicates the permeable zones in the sand and correlates very well with the core log as shown by the portions colored in black.

The electric log did not correlate very well in oil base mud. The self-potential curve was very poor, and, in most cases, the breaks were not indicative of formational changes. The resistivity curve partially indicated the permeable sands as shown by the portions colored in black.

In the past, the drilling time log was indicative of the permeable sand sections, but with diamond coring there seems to be no comparable variation. The coring rate with the conventional core barrel varied between 15 and 120 min. per ft., and, with the diamond core barrel, the coring rate varied between 5 and 15 min. per ft.

The bit log shows the number of conventional cutter heads used, the number of diamond core heads used, and the amount of section cut by each bit.

● **Comparative analysis of coring costs.** An analysis was made comparing conventional coring with diamond coring, and the results with diamond coring were very favorable.

The conventional core barrel cut 119 ft. of formation at an average coring

Colorado find

What appears to be the first commercial oil discovery in La Plata County in southwestern Colorado was made recently. T. C. Hudson No. 1 Schmitt, C NW NE 36-34n-12w, reached a pay sand at 2995 ft. and oil began filling the hole when the bit was only "about an inch" into the formation. Hudson said oil continued to rise in the hole despite cavings and obstructions in the Mancos shale overlying the oil-bearing zone.

Far from other production this is a significant discovery for Colorado, which has basked this year in the success of the Rangely field.

FIG. 3. Outer core barrel with diamond core head attached, hanging in derrick before removing core.

FIG. 4. Inner core barrel partially removed from outer barrel to inspect ball bearing race. Shows method of safely hanging core barrel in derrick.

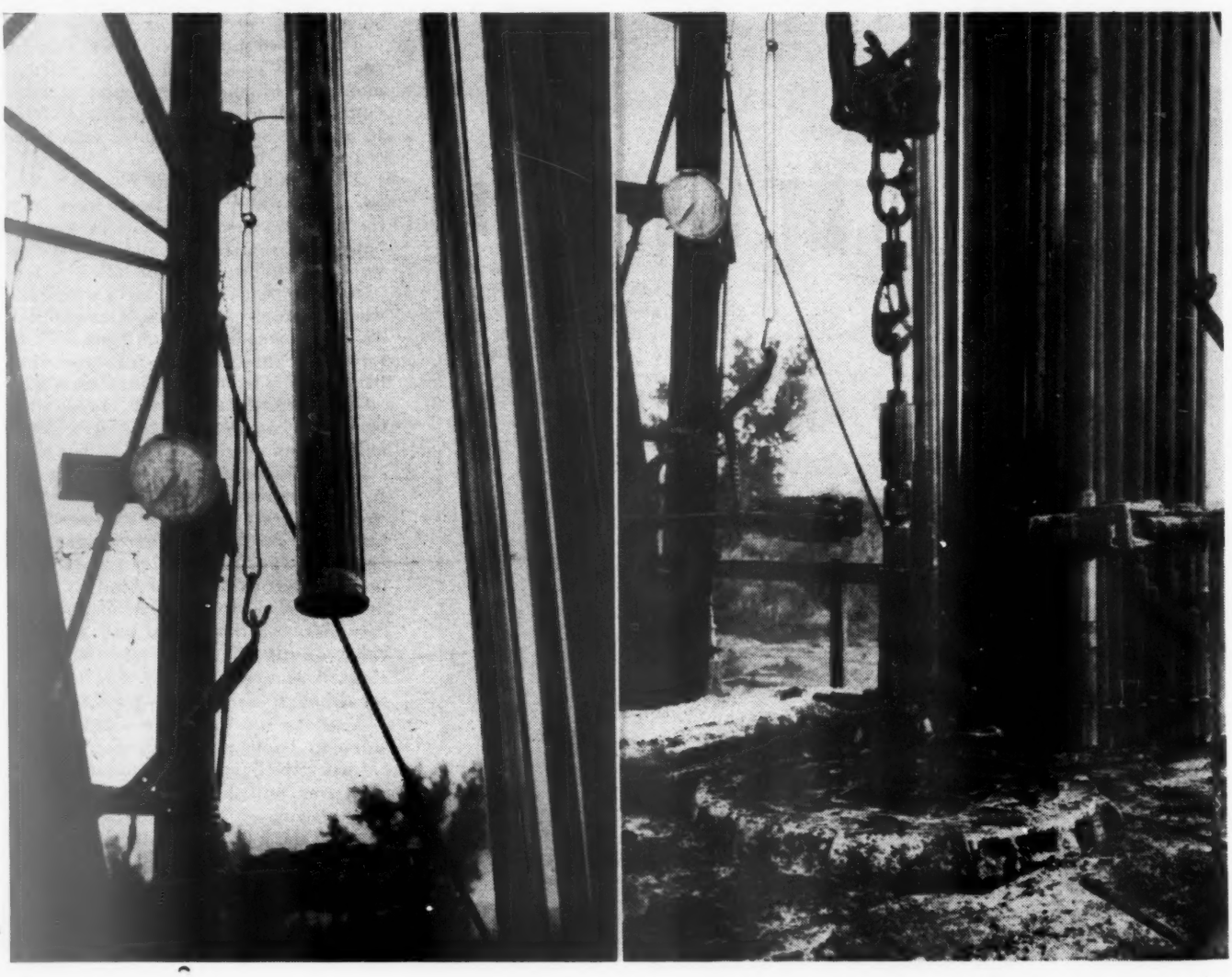


FIG. 5. Diamond core head removed and outer barrel pulled up to expose core before removal.

FIG. 6. Core barrel in position to remove cores with solid core held by core wrench.

time of 43 min. per ft. with 81 per cent core recovery, whereas the diamond core barrel cut 353 ft. of formation at an average coring time of 9.6 min. per ft. with 100 per cent core recovery.

The conventional core barrel cut 19 cores and averaged 6.25 ft. per core, whereas the diamond core barrel cut 15 cores and averaged 23.5 ft. per core.

The conventional core barrel used 19 bits and averaged 6.25 ft. per bit, whereas the diamond core barrel used four bits and averaged 88 ft. per bit, excluding the two bits that were broken before coring any formation.

A comparison of costs for diamond vs. conventional coring indicates a cost of $35.60 per ft. for diamond coring against a cost of $79.20 per ft. for conventional coring in this well.

● **Completion data on Hefley No. 1.** Tubing was landed at 6140 ft., and the oil base mud was displaced with crude oil. The well was completed September 21, 1946, for 155 bbl. of oil per day through a 20/64-in. choke with 80-lb. tubing pressure and 770-lb. casing pressure. The well was shot, cleaned out, and recompleted on October 23, 1946, for 406 bbl. of oil per day through a 20/64-in. choke with 170-lb. tubing pressure and 460-lb. casing pressure.

● **Initial conclusions and recommendations.** Results of the initial trials indicated that:

1. Diamond coring with a 25-ft. special core barrel is faster than conventional coring or drilling through the thick Weber sand section in Rangely.
2. Although the first diamond core bits averaged 88 ft. per bit, diamond core bits should average 200 or more ft. per bit in future coring operations.
3. The drilling rate with diamond core bits averaged about 10 min. per ft.
4. Diamond core bits cut the hole to gauge, eliminating any reaming.
5. Core recovery with diamond coring was 100 per cent.
6. Diamond coring with a 25-ft. special core barrel required more time to recover the core than to drill it.

Court decides for unit plan

The United States circuit court of appeals at New Orleans in a suit by Mrs. Virginia Y. Stott and others against Tide Water Associated Company and Seaboard Oil Company decided in favor of the companies on a unitization of leases for cycling operations.

The defendant companies owned and operated leases covering some 2400 acres in the Long Lake field in Anderson County, Texas, including three tracts owned by the plaintiffs of about 200 acres. Long Lake is essentially a gas field and in order to produce and utilize the gas a cycling plant was constructed and placed in operation by the defendant companies. The plaintiffs were requested to unitize their interests with those of other royalty owners in the area in order to participate in the cycling operations. The plaintiffs refused to join in the unitization and later brought suit against the companies for damages, claiming that wet gas under their land had been replaced by dry gas as a result of the operations.

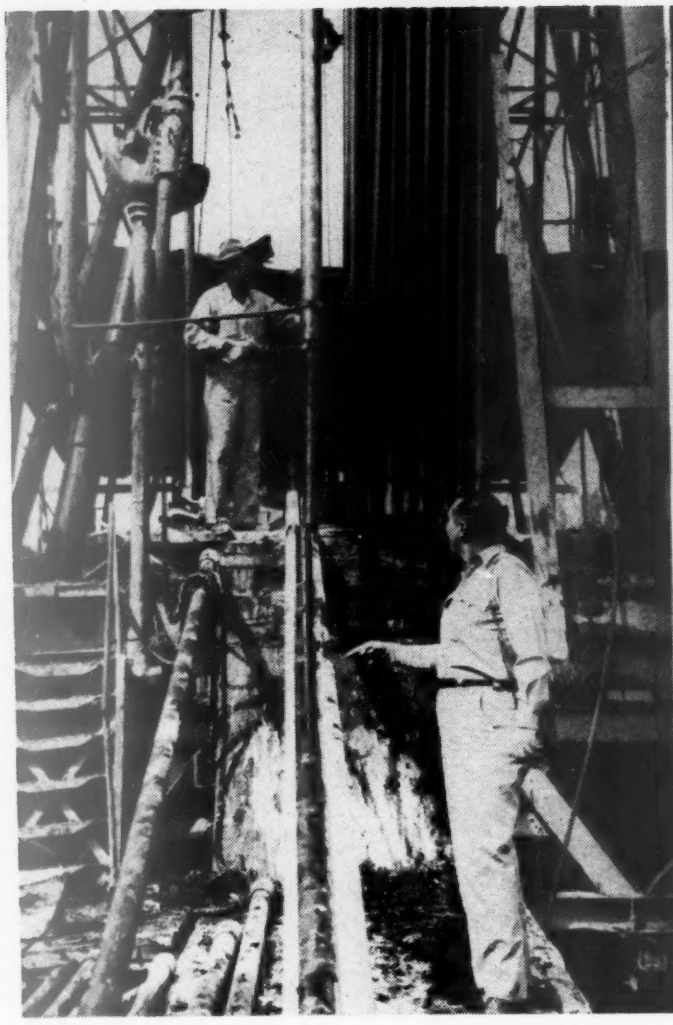


FIG. 7. Core broken and placed in core trough for inspection.

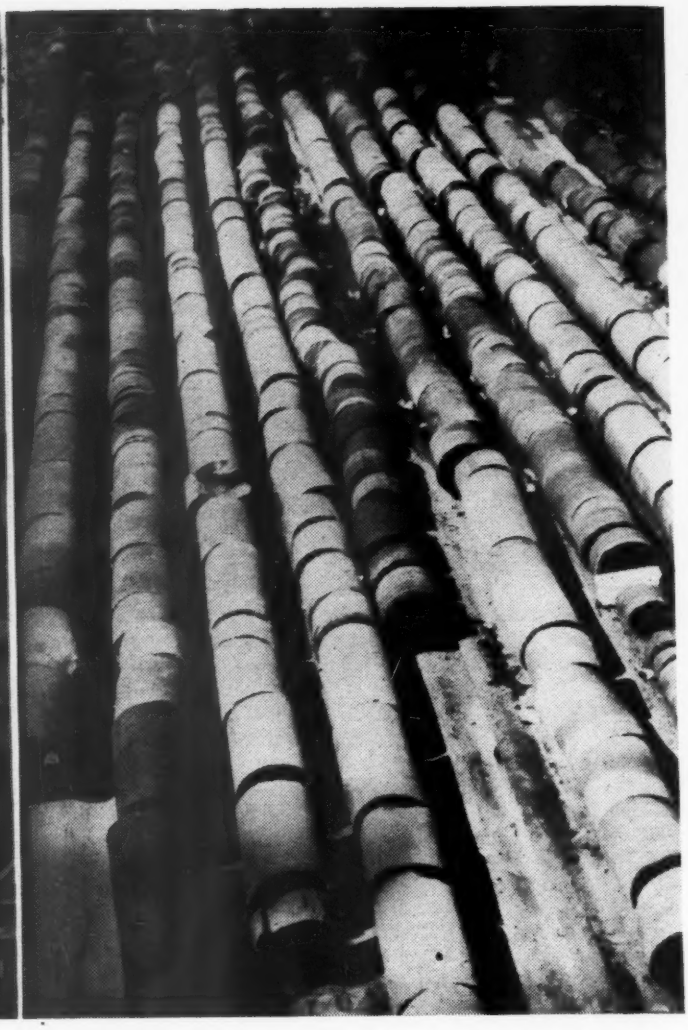


FIG. 8. Approximately 400 ft. of cores after selection of sample plugs. Portions not analyzed are packed and stored.

7. Diamond core bits work very well in oil base mud, for the watercourses were not eroded and the cuttings were completely removed.

The following recommendations were made after the initial tests on Hefley No. 1.

1. Continue diamond coring with the 25-ft. special core barrel, in order to improve the diamond coring technique.

2. Obtain a 50-ft. jointed core barrel, in order to reduce the trip time.

3. Try reverse circulation diamond coring.

● **Diamond coring costs are reduced.** Additional diamond coring in Rangely field since the work on Hefley No. 1 has exceeded initial expectations. The company has cored the Weber sand in five wells with diamond bits. About 3000 ft. of sand section has been penetrated, and coring costs with diamond bits have been reduced to about one-half the former cost of drilling the Weber sand section with conventional rock bits. The cost of diamond coring has now been reduced to approximately $10.00 per ft., and it is thought that this cost will be less as additional wells are drilled with diamond bits.

The average footage cut per diamond bit has increased considerably. One bit has cored 544 ft. before being returned for diamond salvage credit. The coring time still averages about 10 min. per ft., but 50-ft. core barrels are now being used extensively, thus reducing trip time and trouble in making trips.

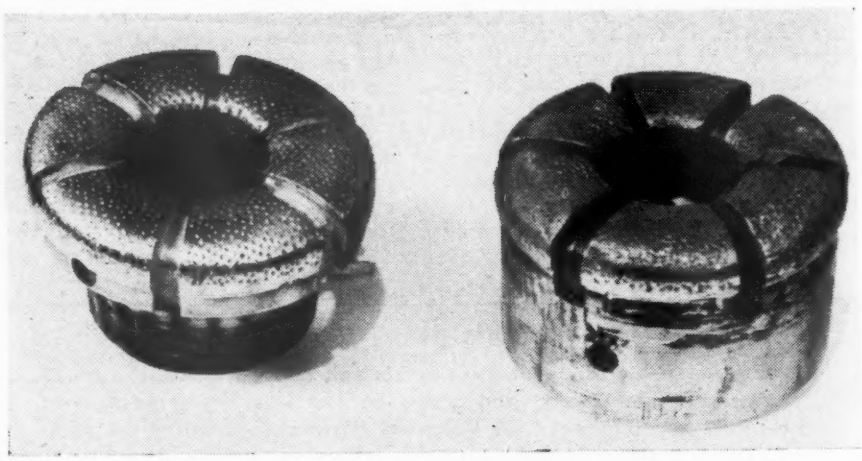


FIG. 9. Bits used with the Carter pressure core barrel.

The company has standardized on the use of 50-ft. diamond core barrels in oil base mud for all future completions in the Rangely field. Although reverse circulation has been tried on four wells, the results have not been sufficiently advantageous to warrant additional work at this time.

Diamond coring in West Texas is being planned in the hope that drilling time and costs can be reduced in certain zones that now require a large number of rock bits and much rig time. ★★★

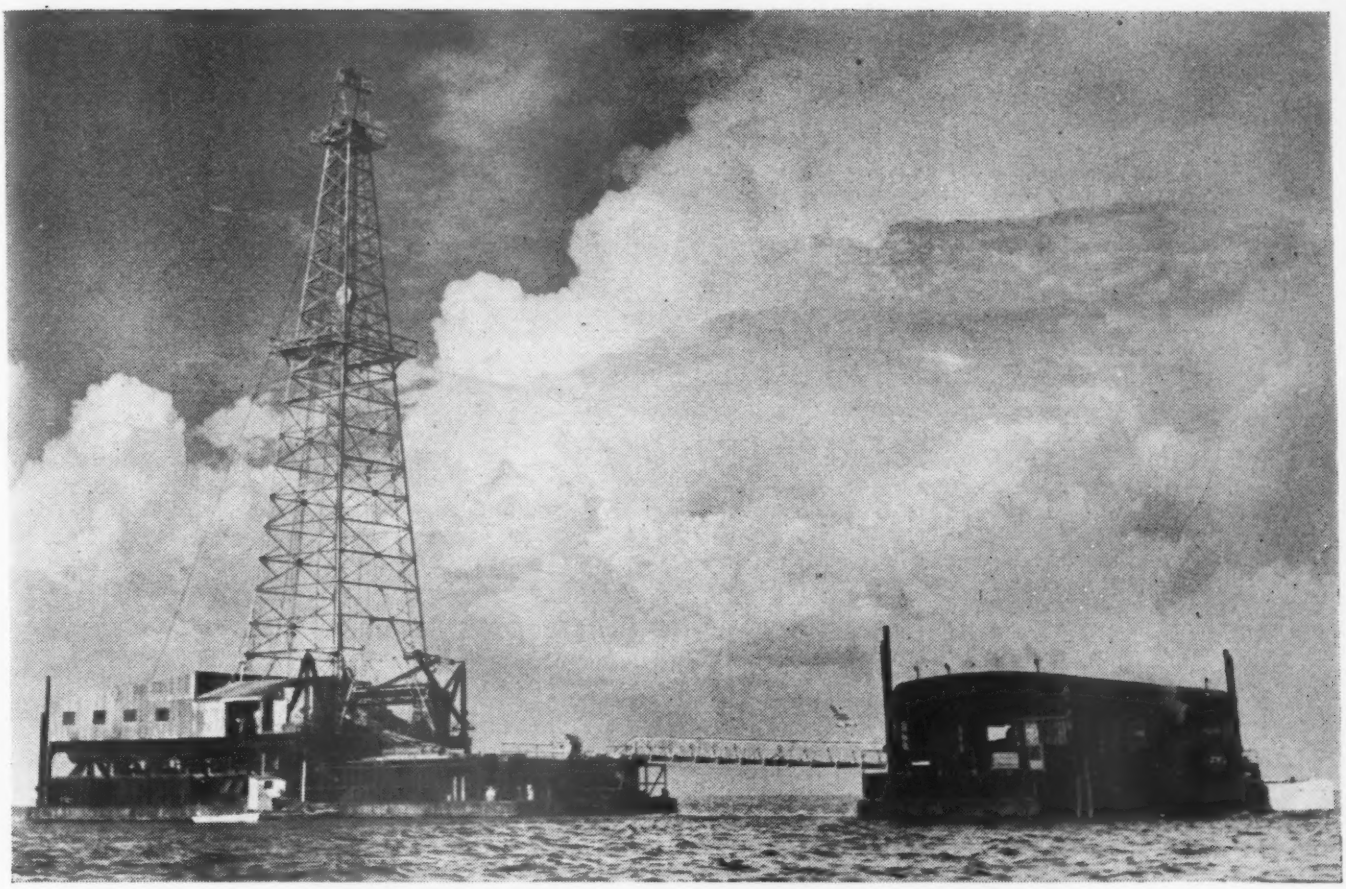


FIG. 1. Diesel electric barge rig on location in Galveston Bay.

Diesel electric barge rig, 2100-hp, designed to drill 15,000-ft. wells

By **K. MARSHALL FAGIN,** *Field Editor*

EXCLUSIVE

ONE of the largest and most powerful barge drilling rigs ever planned has been put into routine operation in the coastal area of Louisiana by the production department of the Humble Oil and Refining Company. It is designed to operate in water about 10 ft. deep.

It was assembled at Barbour's Cut on the Houston Ship Channel and was tested last September on a location in the Red Fish Reef area in Galveston Bay (Fig. 1), where a 3000-ft. well was drilled.

After the first test, the rig was returned to Barbour's Cut for minor changes and additions before it was towed through the intracoastal canal to Bayou Sale near Franklin, Louisiana.

● **Prime movers in power barge.** Three 700-hp, 900-rpm, super-charged diesel engines (Fig. 2) serve as the prime movers for the rig. Each engine is direct-connected to a 375-kw generator with a 60-kw, constant voltage generator mounted on top and driven by V-belts from the main generator shaft. The 60-kw generators are equipped with Thyrite-controlled exciters so that the voltage generated remains constant though the engine speed varies. Fig. 3 shows a set of generators and part of an engine as they are mounted in the power barge, which is 100 ft. long by 30 ft. wide with a 12-ft. deep hull.

The power barge hull is divided into eight main compartments, four outboard compartments and four inboard compartments. The outboard compartments, two on each side, are used for submergence water, and three of the inboard compartments are used for fresh water storage. The fourth inboard compartment is used for fuel oil storage.

Engine wear and fuel consumption are minimized by the use of electro-hydraulic governors that automatically adjust the engine speed between 450 and 900 rpm as the load demand varies. This type of governor permits use of the lowest possible speed commensurate with the load demand.

● **Engines equipped with heat exchangers.** Each engine is provided with a closed cooling system consisting of a tube-type heat exchanger and a motor-driven raw-water pump. Fig. 4 shows one of these pumps mounted on the deck of the barge beneath the engine floor.

The jacket water is circulated through the engines and heat exchangers by pumps built on the engines. The raw water is also pumped through a small heat exchanger for cooling the lubricating oil.

An auxiliary switchboard (Fig. 5), two motor-driven air compressors, a 9-kw diesel generator unit for lights when the large engines are shut down, a small boiler for heating purposes, and a 5-ton, hand-operated traveling crane are the other pieces of equipment mounted on the floor of the power barge.

● **Ward Leonard control system used.** The Ward Leonard system of connecting the motors and generators is used to provide control of the speed of the motors with minimum electrical losses. In this system, the motor field is separately excited from the 60-kw constant voltage generator, and the armature is connected directly to the 375-kw generator armature. The speed and output of

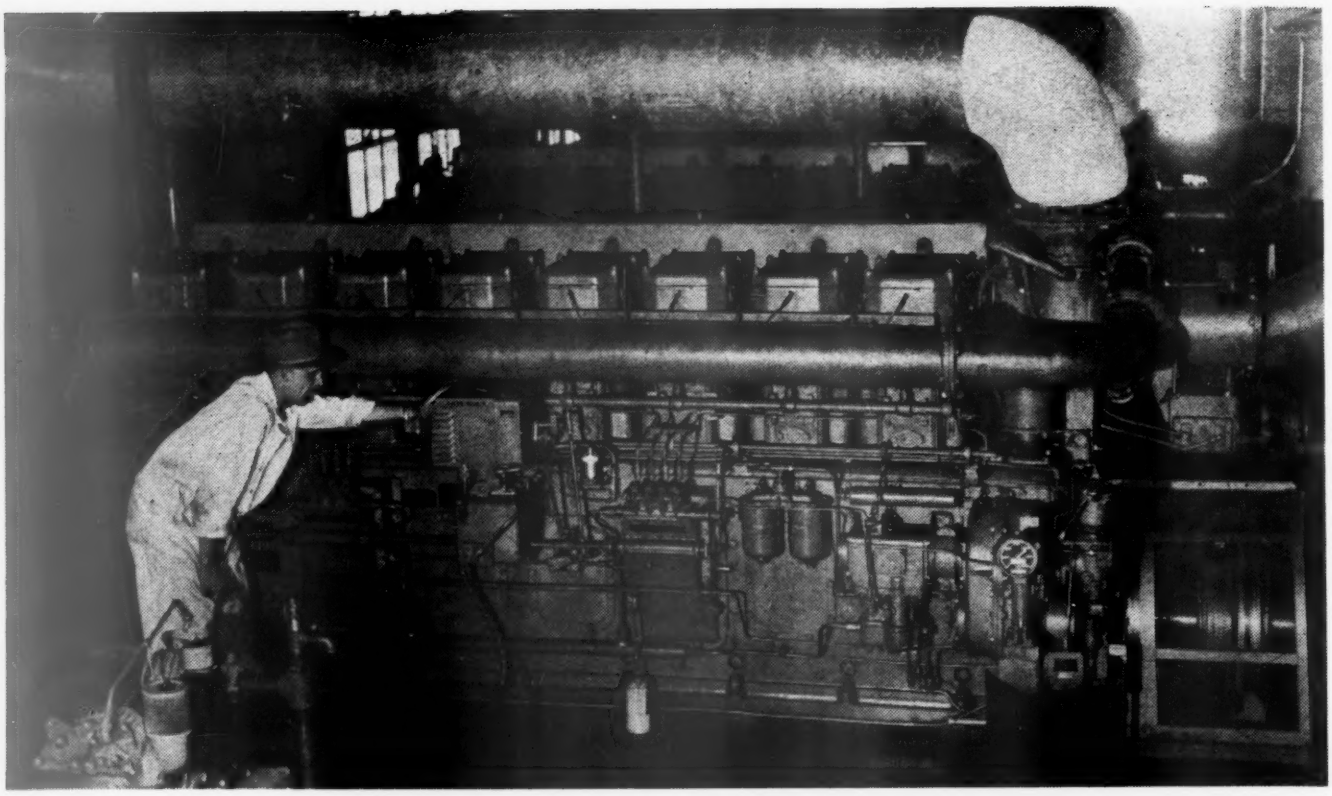
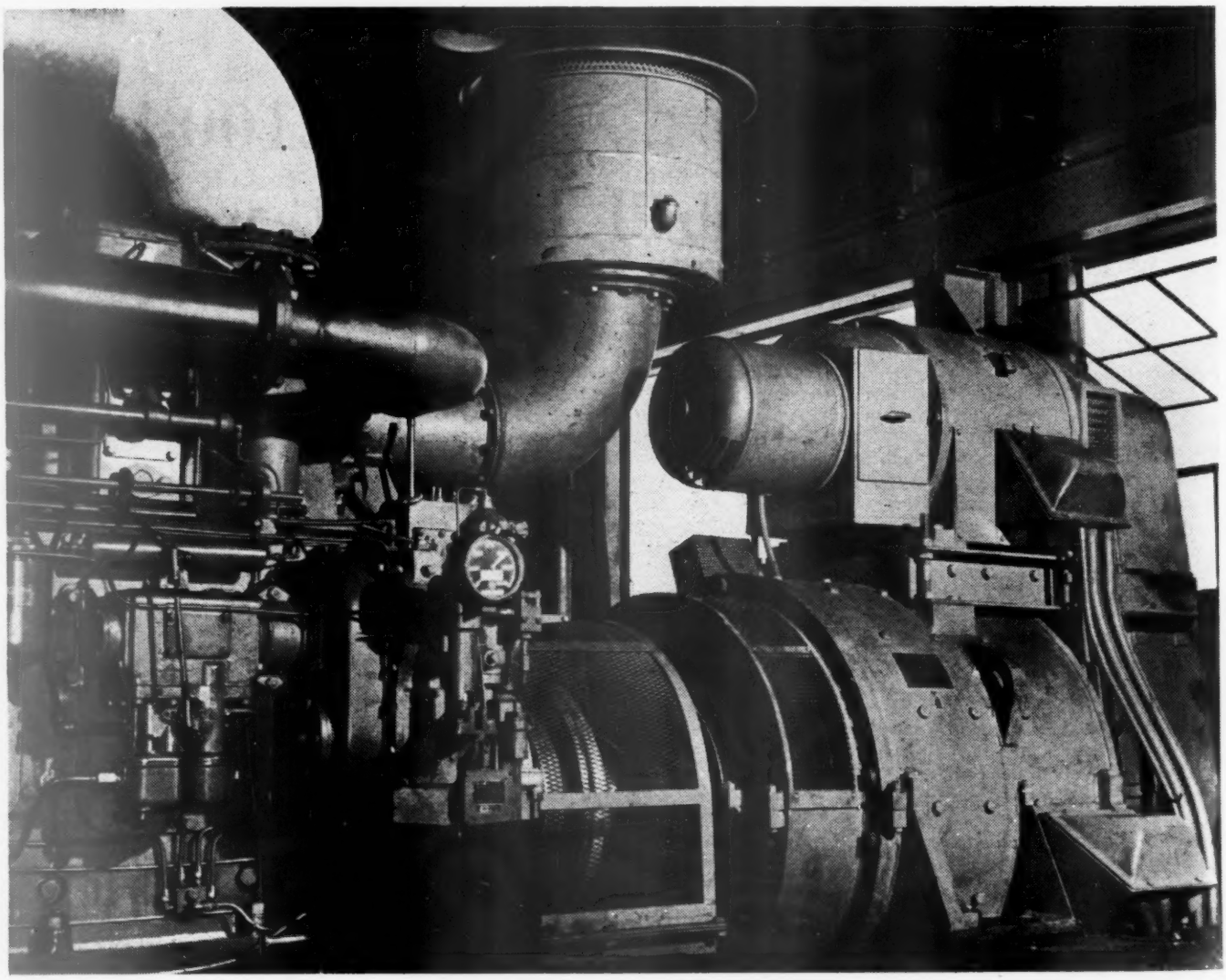


FIG. 2. Above, 700-hp. supercharged diesel engines on power barge.
FIG. 3. Diesel engine and 375-kw generator with 60-kw generator.



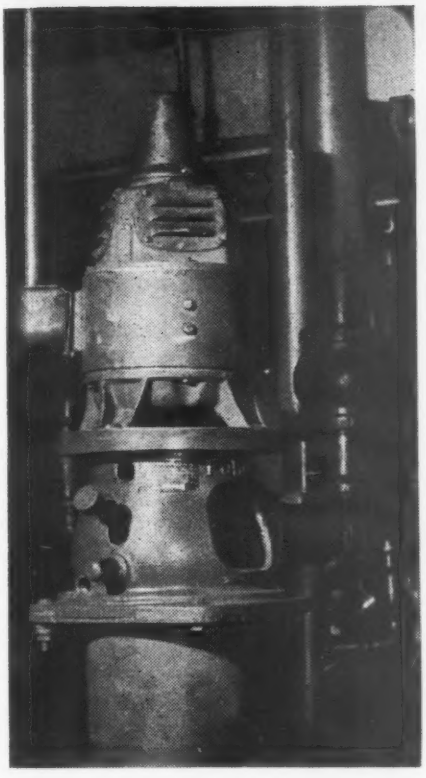


FIG. 4. Fresh water pump mounted on power barge. Large beams at top support diesel engines and generators.

the motor can then be controlled by varying the generator field current.

The excitation of the 375-kw generator could be controlled by means of a variable resistance in the field circuit. The magnitude of the field current, however, would necessitate the use of a bulky controller and considerable electrical loss would result.

The generator field current is supplied by a specially designed motor-driven exciter, however, and excessive electrical losses are avoided by the use of smaller control equipment. This specially designed motor-driven exciter also supplies current for the electro-hydraulic engine governor.

The output of this exciter is controlled by a small variable resistance or rheostat in the field circuit. The field current required by the exciter is very small, and the electrical loss in the rheostat is consequently negligible.

Fig. 6 shows a terminal box and part of one of these motor-driven exciters, which are mounted on the deck of the barge underneath the engine house floor. The heat exchangers, raw-water pumps, oil tanks, air receivers, and fresh water pumps are also mounted on this deck of the power barge.

● **Drilling barge has two hulls.** The drilling barge is of the twin-hull type and is 140 ft. long and 54 ft. wide. The 12-ft. deep hulls differ from the conventional twin-hull design in that the individual barges are offset and the 6-ft. slot extends 86 ft. from the forward end rather than the entire length of the hulls. This design provides more usable space on the afterdecks of the hulls for the mud pumps and mud pump manifold.

Each hull is divided into six main compartments and two collision compartments by means of a longitudinal bulkhead and four transverse bulkheads. All main compartments are used for submergence water except the two center compartments in the starboard hull, which are used for fresh water.

Six vertical centrifugal pumps driven by electric motors are used to pump out the submergence water when raising the barges off location. The mud pump suctions are also connected to the hull compartments to permit any compartment to be emptied in case one of the desubmergence pumps should break down.

● **Drilling barge hulls can be separated.** The two barge hulls are joined together by a 14-ft. superstructure, and, when narrow locks or canals are encountered, the hulls can be floated through separately by removing the tie members between the superstructure on each hull. In addition to supporting the derrick, drawworks, and rotary, the superstructure, which extends 82 ft. from the afterend of each hull, also provides a means of fastening the two hulls.

The drilling derrick is mounted on the superstructure. It is of standard design, 136 ft. high with a 30-ft. base, except that provision is made for the use of hydraulic jacks and shims for leveling it when the barges settle unevenly.

The mud pumps are mounted on the afterdeck of the starboard barge with the active mud pits directly opposite on the port barge. Two 7¾-in. by 20-in. mud pumps are used for drilling or circulating. Each one is driven by a 500-hp, mill-type motor. A 5-in. by 8-in. pump driven by a 60-hp motor is used for mixing mud.

The discharge and suction manifolds are arranged so that the large pumps may be compounded in series or parallel when necessary. Each of the large pumps is equipped with a precharged surge chamber designed by Humble. The surge chamber cushions the discharge surges and materially reduces vibration in the discharge manifold piping and whipping of the rotary drilling hose. The suction manifold is connected to all hull compartments in the barges as well as to the reserve mud tanks situated on the forward deck.

● **Four-speed drawworks has 1000-hp motor.** A conventional 4-speed drawworks equipped with air brakes is driven by a mill-type electric motor that is rated at 1000 hp at 725 rpm for continuous duty. It will deliver about 1700 hp, however, for intermittent duty such as hoisting drill pipe.

The rotary is driven independently by

FIG. 5. Auxiliary switchboard on power barge.

FIG. 6. Junction box for control wires, left. Partial view of motor-driven exciter in foreground.

a 300-hp, mill-type motor direct-connected to the pinion shaft with a flexible coupling. One-half of the coupling is equipped with a sprocket so that a chain drive from the drawworks could be used.

● **Drillers assisted by meters on rotary motor.** The torque output of the rotary motor is directly proportional to the armature current, and the speed of the motor is proportional to the armature voltage. An ammeter and voltmeter calibrated in pound-foot torque and revolutions per minute, respectively, are mounted in plain view of the driller.

One main generator is connected to one of the large mud pump motors, one to the drawworks motor, and one to the rotary motor for normal drilling operations. All three generators can be connected to the drawworks when hoisting.

The mud-mixing pump, shale shaker, blower, and other auxiliaries are operated by electricity supplied by the 60-kw, constant voltage generators.

A coring reel driven by a 300-hp motor is mounted on the derrick floor. It is capable of spooling 18,000 ft. of 5/8-in. wire rope.

● **Pneumatically-operated blowout preventers.** Blowout preventers are operated by a 4-in. by 1¾-in. by 4-in. duplex pump driven by air. The air compressor is driven by an electric motor, and, together with the regulating equipment and discharge manifold, are unitized on skids with the duplex pump.

The rotary slips are pneumatically operated by a valve conveniently placed near the driller's position. Other equipment is suitable for drilling 15,000 ft.

The motors driving the pumps, drawworks, coring reel, and rotary are ventilated by air from a blower situated on the afterend of the superstructure. All other motors on the drilling barge are of the totally enclosed type.

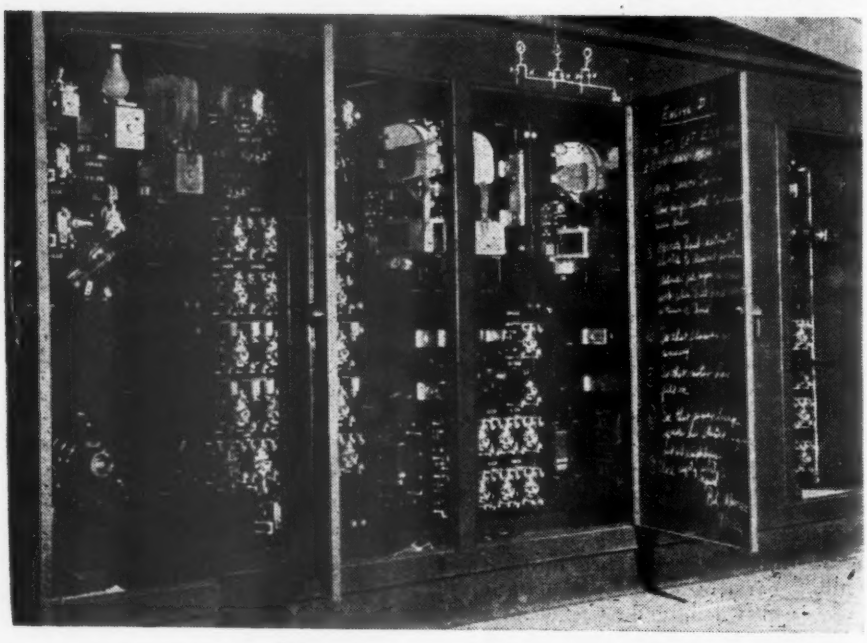
● **Large housed section on superstructure.** The main electrical switchboard (Fig. 7), a diesel electric auxiliary light plant, and the blower, which supplies air to the separately cooled motors, are situated in the central part of the housed section on the superstructure.

The remainder of the housed section is divided into rooms for a mud laboratory, change rooms, tile bath, and office on one side, and a bunk room and dry mud storage room on the other side. All rooms except the bath are oak-floored.

● **Walkway connects drilling and power barges.** Pipe racks are placed on top of the reserve mud tanks on the forward end of the drilling barge. These are long enough to accommodate API range 3 casing (40-ft. joints). A hinged walkway 75 ft. long connects the forward end of the pipe rack with the power barge. It provides a means of communication with the power barge and also supports all power and control cables.

A stiff-leg derrick or cargo hoist with a capacity of five tons is mounted on each corner of the superstructure next to the pipe rack. These are used for handling drill pipe, casing, and dry mud. The hoist on the port side is operated by compressed air motors inasmuch as most of the loading and unloading is done from the port side of the drilling barge. The starboard hoist is operated manually with hand winches. ★★★

FIG. 7. Below, main switchboard on drilling barge.



Setting meter run at Many, Louisiana, with winch truck.

How gas was put through Big Inch lines

By **FRANK H. LOVE,** *Managing Editor*

EXCLUSIVE

When the War Assets Administration entered into a contract with Tennessee Gas and Transmission Company giving that company permission to operate the Big Inch and Little Inch pipe lines as natural gas carriers to alleviate the fuel shortage in eastern states, speculation was widespread regarding how this could be accomplished soon enough to be of material assistance. Gardiner Symonds, president of Tennessee, in negotiating the contract, had promised that gas could be delivered to consumers within a matter of days if good weather held out. Inasmuch as neither of the "Inch" lines was equipped with compressor stations to transmit gas the question quite naturally arose as to how this could be done in such a short period of time. Some critics even went so far as to state that it could not be done. Such critics, as it later developed, released their statements without being fully informed on certain essential facts. Actually, gas was delivered to distribution points in Ohio within six days from the time the government granted its permission, and the mechanical problems involved were relatively simple. This was due to the fortunate proximity of the Tennessee system to the Inch lines (see Map, Fig. 1), and also due to the fact that Tennessee had surplus compressor horsepower on its system that could be utilized immediately.

Some time previously the Federal Power Commission had granted the company permission to loop portions of its line and increase compressor horsepower at certain of its stations. The compressors had been installed but the loops had not been laid due to inability to procure pipe, hence surplus horsepower was available for this emergency.

To put the WEP lines into operation, the Tennessee system was connected to the Little Big Inch line by means of a

crossover at a point near Many, Louisiana, where the two lines cross, and the section of the Little Big Inch line between Beaumont and that point was blocked off. The surplus compressor horsepower at the No. 2 station (East Bernard, Texas) and the No. 4 station (Jasper, Texas) was then used to move gas from Tennessee's line into the Little Big Inch and on east to distribution areas.

The initial volume of gas delivered was later increased when the Big Inch was purged of nitrogen, with which the line was filled during its inactivity, and placed in service, using independent gas supply sources. By January 1 the output of the two Inch lines was approximately 100,000,000 cu. ft. a day, and within a few days it was scheduled to rise to 150,000,000.

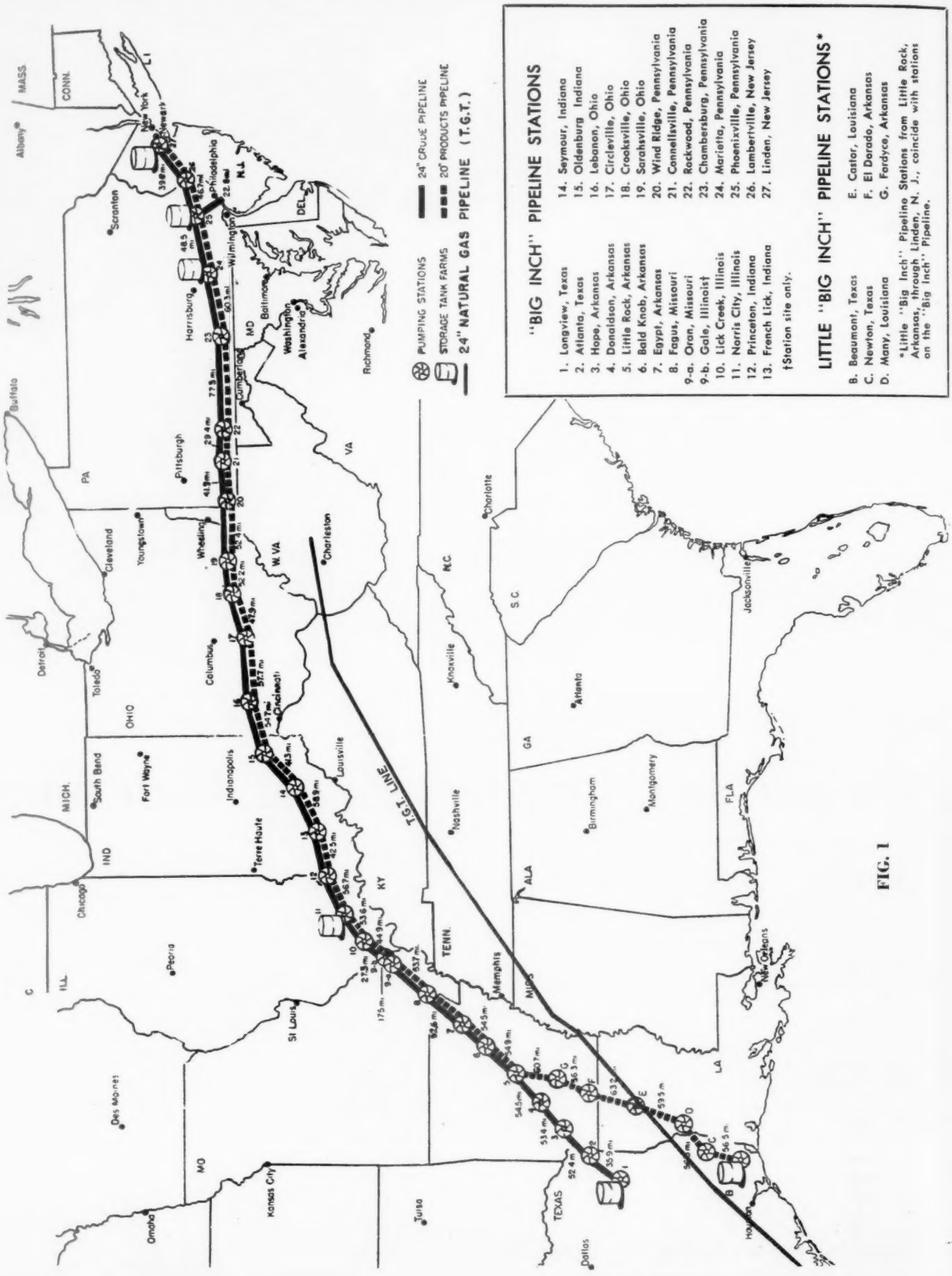
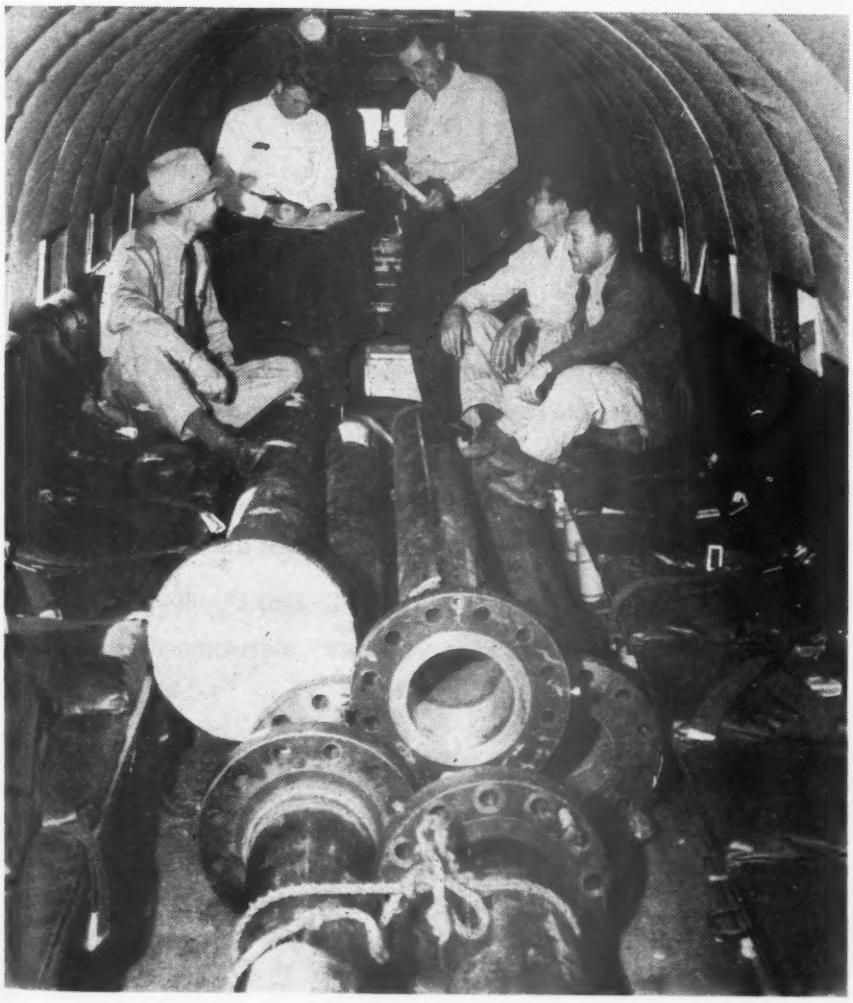


FIG. 1

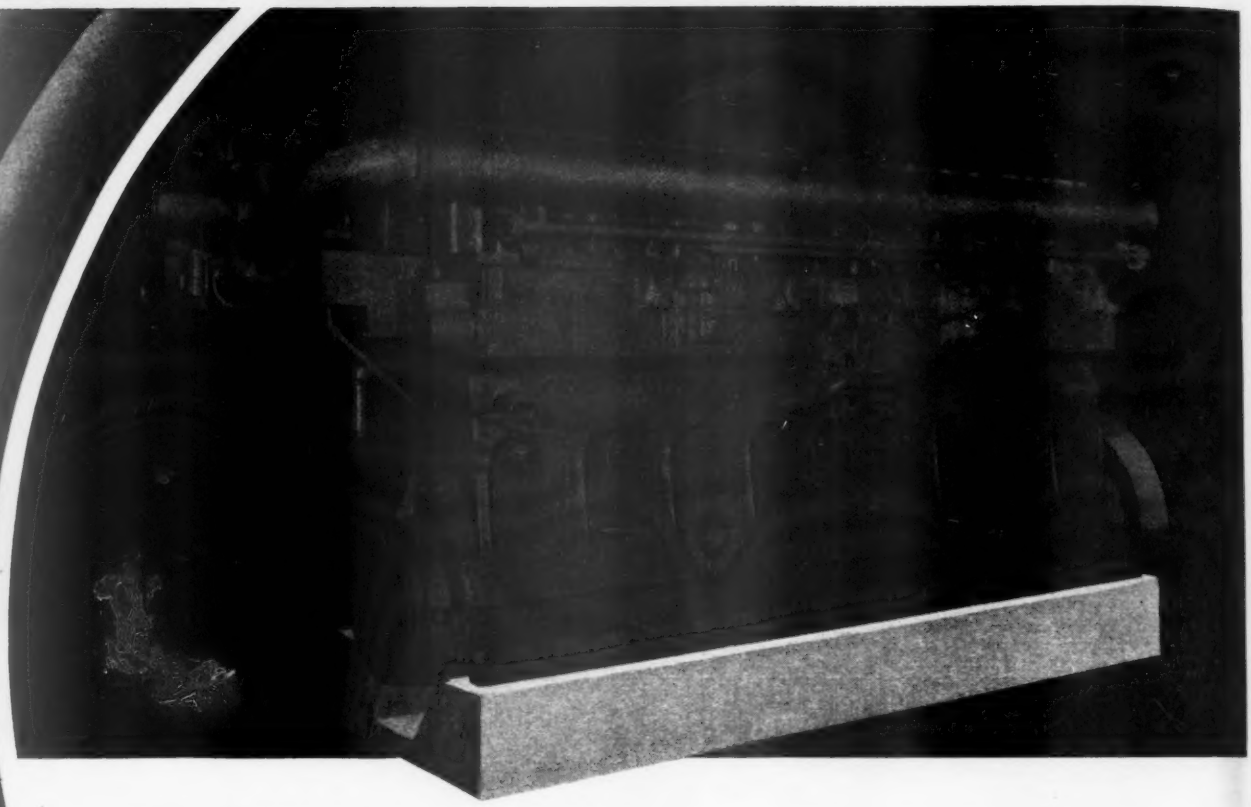


Above—Leveling up meter run at Many. Left—Meter runs were prefabricated in Houston and flown to Natchitoches, from where they were trucked to the installation site.

The crossover at Many, Louisiana, the "key" operation so to speak, was installed in a matter of 24 hours. Previously, the meter runs had been pre-fabricated in Houston, Texas, and flown to Natchitoches, Louisiana, in a DC-3, from where they were trucked to the tie-in site. Later another crossover was made near Little Rock, Arkansas, between the Big Inch and the Little Big Inch lines. This latter imparts flexibility to the operation of the lines. The two lines are being operated separately, but should anything happen to the source of gas supply of either of the lines, by blocking-off, gas can be run through both lines from a single source.

The 1265-mile pipe line system of Tennessee Gas and Transmission Company originates at Agua Dulce, Texas, near Corpus Christi, and crosses the states of Louisiana, Arkansas, Mississippi, Tennessee, Kentucky, and terminates at Broad Run, West Virginia. The line was completed in the fall of 1944. Since then the company has expanded its capacity from 200,000,000 cu. ft. a day to 282,000,000 cu. ft., and its application to increase this to 381,000,000 cu. ft. has been approved by the Federal Power Commission. This program is now under way. In addition, Tennessee Gas and Transmission Company has an application pending to increase its capacity to 600,000,000 cu. ft. a day. Home offices of the company are in Houston, Texas. ★ ★ ★

GAS DIESELS FOR



AGAIN Cooper-Bessemer engines have been selected to furnish dependable, efficient power for one of the industry's major projects — Creole Petroleum Corporation's new oil line from La Salina to the Peninsula in Venezuela.

This new line is to have greater diameter than any other oil line in the world today. It is being powered by twelve Cooper-Bessemer Type LS-8 Gas Diesel engines, six at each of two pumping stations. Four more engines, supercharged LS-8 Diesels will drive generators in Creole Petroleum's Amuay Bay power station, for refinery operation, for loading pumps, and for discharging oil to tankers at their docks.

Four Cooper-Bessemer Type LS-8 Supercharged Diesel engines were selected for the Creole Petroleum Amuay Power Station. They are rated 1575 hp at 327 rpm driving 1100 kw generators. These units are also built as gas diesels with the same horsepower rating.

Particularly newsworthy is the fact that the LS Gas Diesel engines are using Cooper-Bessemer's revolutionary development that

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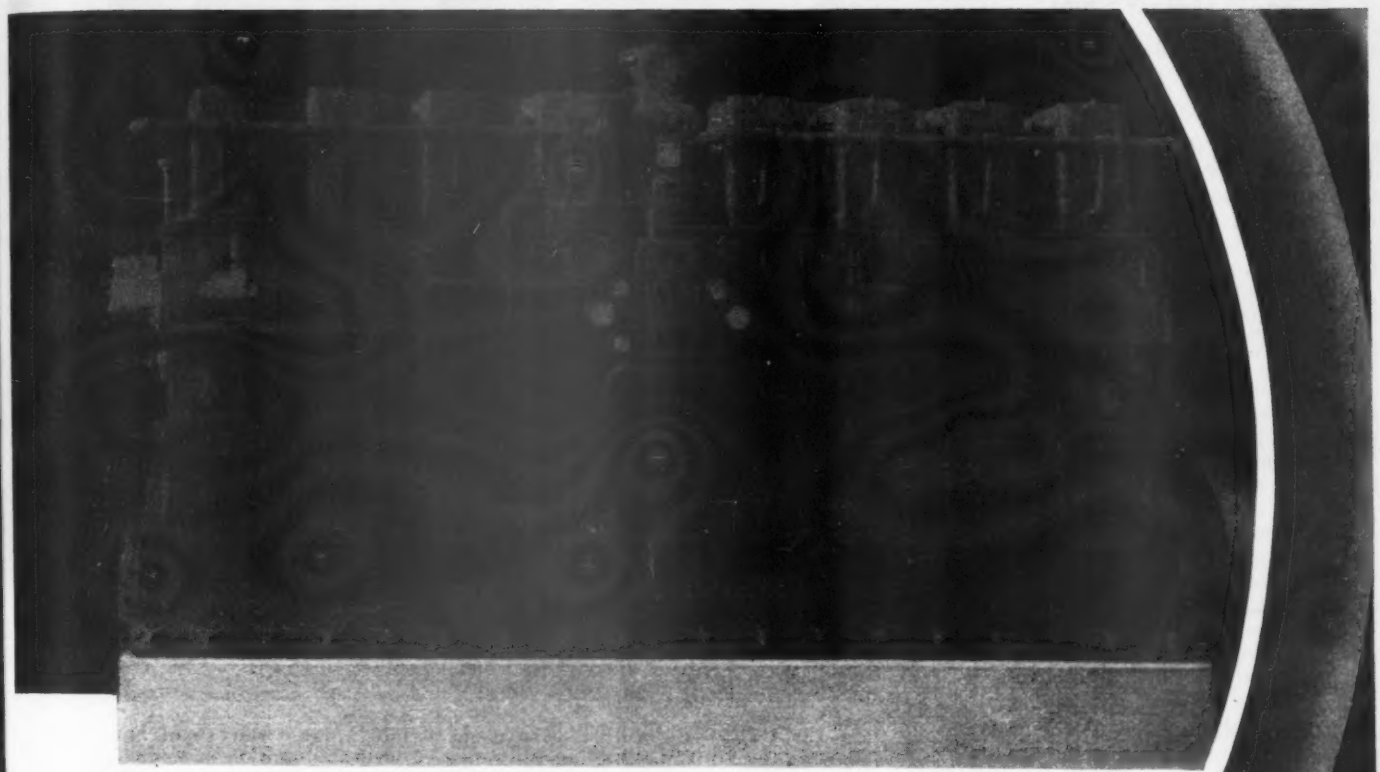

makes it possible for the first time to burn gas, or virtually any combination of gas and oil on the full Diesel cycle. It is a development offering big economies in thermal efficiency, as well as other obvious advantages for various services in the oil and gas industry.

In Creole Petroleum's service, the engines will be operated on a combination of gas and crude oil.

Perhaps Cooper-Bessemer gas-diesels would be ideal for some of your requirements. Descriptive bulletins are now available.

Cooper-Bessemer 8-cylinder Type LS gas-Diesel, 12 in all, will serve Creole Petroleum Corporation in two ways . . . driving oil line pumps. Ratings are 1000 bhp at 300 rpm and 1095 bhp at 327 rpm respectively.

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Hydrocarbons in petroleum*

By **FREDERICK D. ROSSINI**

Thermochemistry and Hydrocarbons, Section Chief,
National Bureau of Standards

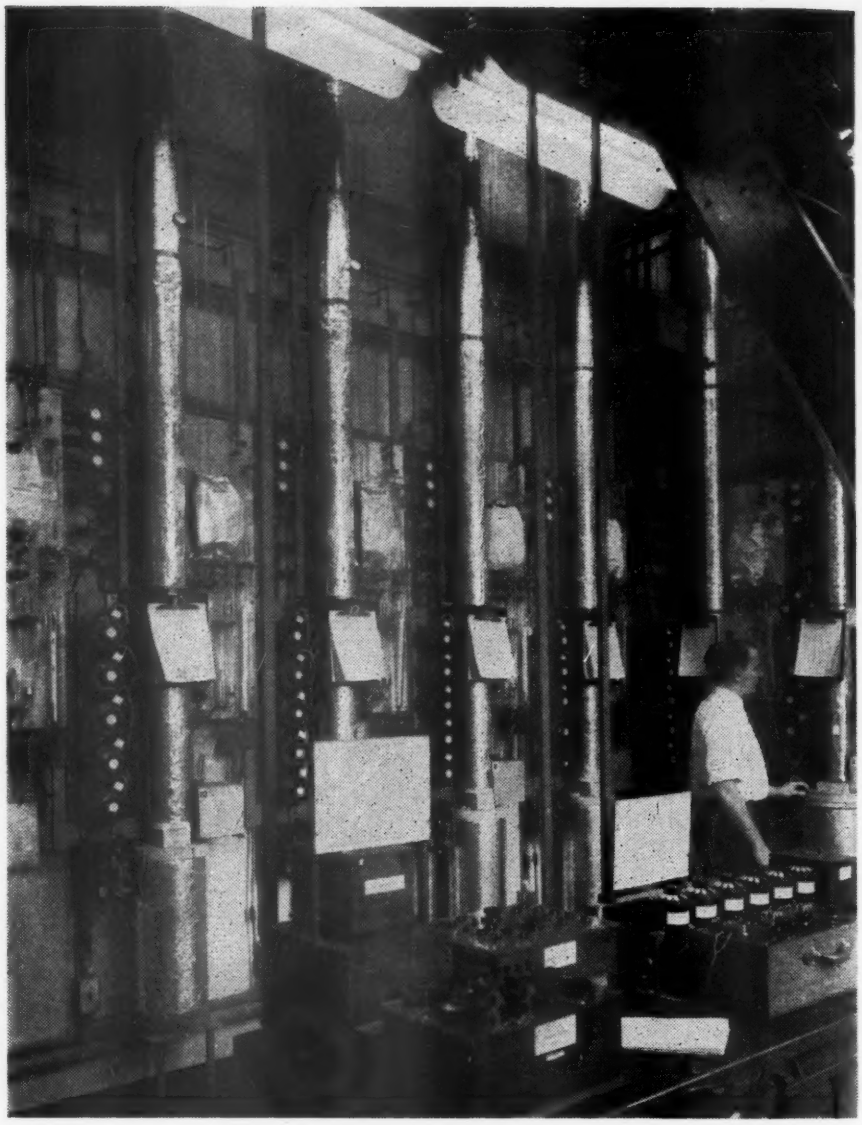

FIG. 1. A view of the distillation room at the National Bureau of Standards showing the 18-ft. distillation columns used in the separation of hydrocarbons from petroleum. Between the columns are the service outlets, controlled pressure manifolds, electrical power controls, and receiving assemblies. The instruments in the foreground are for the thermometric system. Fifteen distilling columns are operated 24 hr. a day, every day in the year.

FOR some years there has been under way in the petroleum industry a transition from the production of a few exceedingly broad fractions of petroleum, having general properties—such as the gas, gasoline, kerosine, lubricating oil, and wax—to the manufacture of many different narrow cuts having specialized properties. The general properties of each of the broad fractions have been such as to satisfy fairly well the requirements of a number of different services; however, the need for greater efficiency, higher speeds, and more concentrated power, the use of high pressure and high and low temperatures, and the invention and development of devices for improving the comfort and welfare of man, inevitably lead to the necessity of manufacturing materials of specialized properties that can better fill the ever-expanding and more exacting requirements of today.

Although investigations on the nature of petroleum have been going on for many decades, it was not until about 25 or 30 years ago that the petroleum industry itself began to consider seriously the chemical constitution of its raw material. With a few notable exceptions, the researches on the hydrocarbons in petroleum had been sporadic and casual; and relative to the importance, magnitude, and complexity of the problem, greatly limited in scope. About 25 years ago the presence of a number of hydrocarbons in the gasoline fraction of petroleum was reported, but for molecules of more than five carbon atoms the evidence was in most cases based upon the products obtained by chemical treatment of certain petroleum fractions or upon volume peaks in the distillation curve. What was needed was a comprehensive and unified investigation of the chemical constituents based upon the actual isolation of pure hydrocarbons from the crude oil.

In 1927 a comprehensive investigation on the isolation and identification of hydrocarbons in petroleum was begun at the National Bureau of Standards, sponsored jointly by the Bureau and the American Petroleum Institute. The investigation has to date involved a total of about 200 man-years of research and has resulted in the separation of 72 hydrocarbons from petroleum. At the present time the staff of the American Petroleum Institute at the Bureau consists of 30 research chemists and 12 laboratory assistants, supervised by the writer. The investigations, under A. P. I. Research Project 6, are advised by a special committee appointed by the American Petroleum Institute.

All hydrocarbons in petroleum are composed of paraffin, cycloparaffin (naphthene), aromatic, or mixed cycloparaffin aromatic groups, or combinations of these. No olefin or acetylene hydrocarbons appear to occur naturally in petroleum to any significant extent. The problem is to separate the complex mixture of hydrocarbons that is petroleum and to obtain therefrom the unaltered major components in a substantially pure state.

To be successful, any process of fractionation must involve a physical property that has significantly different values for the several components of the mixture to be separated. Furthermore, the process must be one for which there is available, or can be developed, a workable apparatus.

The standard processes of fractionation used in this work are distillation, extraction, adsorption, and crystallization, which depend, respectively, on the properties of vapor-pressure (or boiling point), solubility, adsorbability, and

*A summary of the work of the American Petroleum Institute Research Project 6 at the National Bureau of Standards. The research staff engaged in this work consists of Frederick D. Rossini, Beveridge J. Mair, Charles B. Willingham, Augustus R. Glasgow, Jr., Alphonse F. Forziati, Anton J. Streiff, Morton B. Epstein, Vincent A. Sedlak, Evelyn T. Murphy, A. J. Sweetman, Janice C. Cahill, and Laurel F. Soule.

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freezing point. The following are the variations that are used:

I. Distillation.
   1. At one fixed pressure.
   2. Alternately at two fixed pressures.
   3. With an azeotrope-forming substance.

II. Extraction.
   1. With different solvents.
   2. At different temperatures.

III. Adsorption.
   1. With different adsorbents.
   2. At different temperatures.

IV. Crystallization.
   1. From the mixture of hydrocarbons, with centrifuging.
   2. From a solution of the hydrocarbons in an appropriate solvent, with centrifuging.

With respect to the nature of the separation attainable, the processes of fractionation (excluding crystallization) may be divided according to whether they fractionate primarily with respect to size of molecule or to type of molecule. Separation primarily according to size of molecule (or boiling point or molecular weight) is effected by distillation at one fixed pressure. Separation primarily according to type of molecule is effected by distillation alternately at two fixed pressures, by distillation with an azeotrope-forming substance, by extraction, and by adsorption. In connection with separation by crystallization, two general statements may be made regarding hydrocarbons: (a) For a given number of carbon atoms in the molecule, the freezing point usually increases with increase in the symmetry of the molecule; (b) for a given degree of symmetry of the molecule, the freezing point usually increases with increase in the size of the molecule.

Except for those hydrocarbons of low molecular weight, which in boiling point are relatively far removed from their neighbors, and except for certain other hydrocarbons which are present in relatively large amounts (as normal paraffins in a Pennsylvania or Mid-Continent petroleum), regular distillation alone is not sufficient to separate a pure hydrocarbon from petroleum, and one or more of the other methods of fractionation must also be used. The order in which the several methods are used is determined by the preceding method. Thus, although a given process may be ineffective when used alone, its systematic use in appropriate combination with other processes can often lead to the complete separation of an otherwise unseparable constituent.

Distillation is the most important fractionating process for separating hydrocarbons of the gasoline and kerosine fractions. This is because distillation can separate either by size or by type of molecule, according to whether one operates at a fixed pressure on the one hand, or alternately at two fixed pressures, or with an azeotrope-forming substance, on the other hand. For each of the several kinds of distillation the same rectifying columns may be used, with substantially the same procedure.

In the distillation laboratory at the National Bureau of Standards there are 15 rectifying columns in continuous operation, 24 hours per day, 7 days per week, every day in the year. These columns have separating efficiencies equivalent to from about 125 ot 200 theoretical plates and are usually operated with reflux ratios from 125:1 up to 200:1, while the rate of removing distillate is from 2 to 12½ ml of liquid per hr. The time of distilling a given charge may vary from 600 to 2100 hr. of continuous operation.

When a mixture of two hydrocarbons of different types but of the same normal boiling point is obtained by distillation at the normal pressure, it can frequently be resolved by alternately distilling at the normal pressure and at a reduced pressure. When the normal pressure is 760 mm Hg and the reduced pressure is 100 mm Hg, the downward displacement of the boiling point for several types of hydrocarbons, referred to the normal paraffins of the same normal boiling point as zero, is roughly as follows: normal paraffins 0 C; isoparaffins, 0 to 2.5 C: cycloparaffins (naphthenes), 1.5 to 4.5 C; alkylbenzenes, 0 to 2 C; alkylnaphthalenes 3 to 4 C. Differences of 1 C are sufficient to produce separation in a column of high efficiency.

Distillation with an azeotrope-forming substance is useful for separating hydrocarbons of about the same boiling point but of different types. Most polar organic molecules form minimum-boiling azeotropic mixtures with hydrocarbons. That is to say, in such mixtures, the given hydrocarbons have partial pressures greatly in excess of what they normally would have in an ideal solution at the same temperature and concentration. Comparing compounds of the same normal boiling point, the greatest excess of partial pressure is produced in the paraffins, next greatest in the cycloparaffins (naphthenes), with the monoolefins, diolefins, mononuclear aromatics, and dinuclear aromatics usually following in that or-

FIG. 2. A view of the freezing point appartus used to determine the purity of hydrocarbons at the National Bureau of Standards. Directly in front of the operator is shown the high precision resistance bridge (with galvanometer scale) and electric stop clock. On either side of the operator can be seen the freezing tubes surrounded by refrigerant. Inserted in each freezing tube is a platinum resistance thermometer and a stirrer, operated from overhead by an electric stirring motor. The suspended galvanometer is between the two motors.

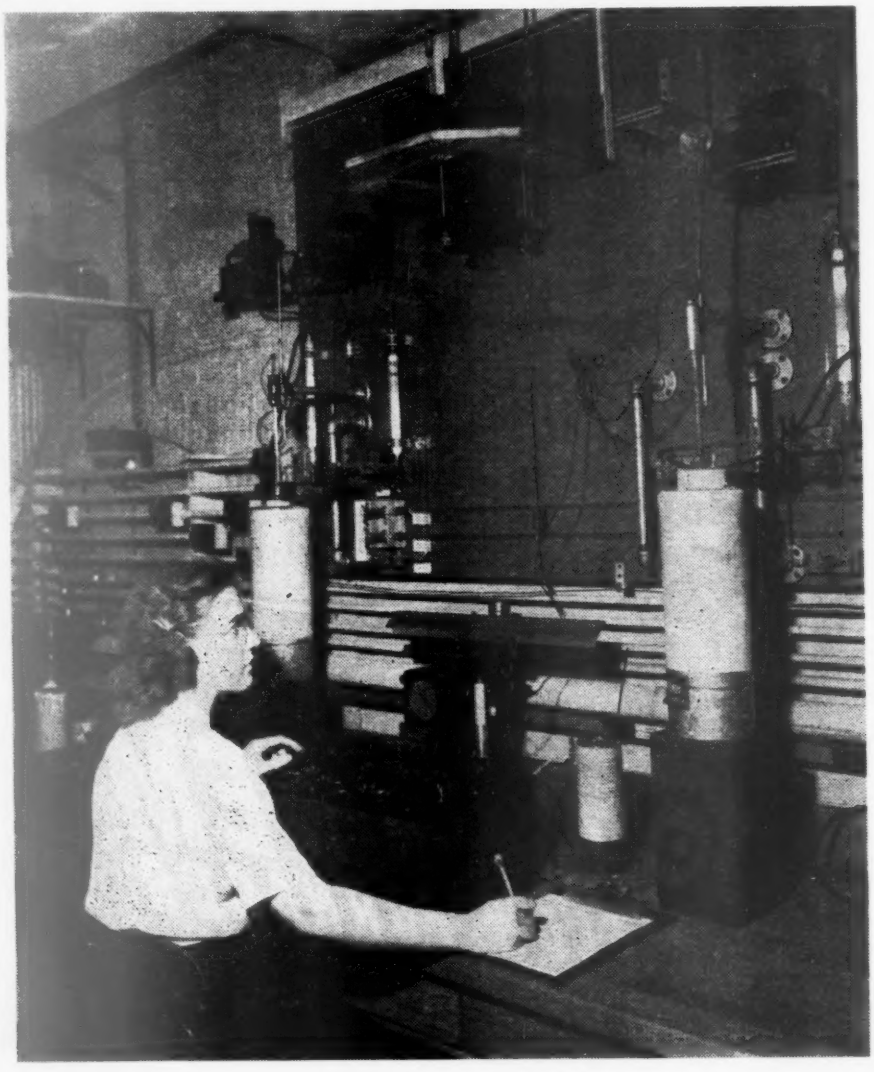

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TABLE I

Hydrocarbons separated from Mid-Continent petroleum by the API Research Project 6 at the National Bureau of Standards

No.	Formula	Name	Type	B. P., °C.
1	CH_4	methane	paraffin	—161.6
2	C_2H_6	ethane	paraffin	— 88.9
3	C_3H_8	propane	paraffin	— 42.1
4	C_4H_{10}	isobutane	paraffin	— 11.7
5	C_4H_{10}	n-butane	paraffin	— 0.5
6	C_5H_{12}	2-methylbutane	paraffin	27.8
7	C_5H_{12}	n-pentane	paraffin	36.1
8	C_5H_{10}	cyclopentane	cycloparaffin	49.5
9	C_6H_{14}	2,3-dimethylbutane	paraffin	58.0
10	C_6H_{14}	2-methylpentane	paraffin	60.3
11	C_6H_{14}	3-methylpentane	paraffin	63.3
12	C_6H_{14}	n-hexane	paraffin	68.7
13	C_6H_{12}	methylcyclopentane	cycloparaffin	71.9
14	C_7H_{16}	2,2-dimethylpentane	paraffin	79.2
15	C_6H_6	benzene	aromatic	80.1
16	C_6H_{12}	cyclohexane	cycloparaffin	80.8
17	C_7H_{14}	1,1-dimethylcyclopentane	cycloparaffin	87.5
18	C_7H_{16}	2-methylhexane	paraffin	90.0
19	C_7H_{14}	trans-1,3-dimethylcyclopentane	cycloparaffin	90.9
20	C_7H_{14}	trans-1,2-dimethylcyclopentane	cycloparaffin	91.9
21	C_7H_{16}	3-methylhexane	paraffin	92.0
22	C_7H_{16}	n-heptane	paraffin	98.4
23	C_7H_{14}	methylcyclohexane	cycloparaffin	100.9
24	C_7H_{14}	ethylcyclopentane	cycloparaffin	103.5
25	C_8H_{16}	1,1,3-trimethylcyclopentane	cycloparaffin	105.0
26	C_8H_{18}	2,2-dimethylhexane	paraffin	106.8
27	C_7H_8	toluene	aromatic	110.6
28	C_8H_{18}	2-methylheptane	paraffin	117.6
29	C_8H_{16}	1,1-dimethylcyclohexane*	cycloparaffin	119.8
30	C_8H_{16}	trans-1,3-dimethylcyclohexane	cycloparaffin	120.3
31	C_8H_{16}	trans-1,2-dimethylcyclohexane*	cycloparaffin	123.4
32	C_8H_{18}	n-octane	paraffin	125.6
33	C_8H_{16}	ethylcyclohexane	cycloparaffin	131.8
34	C_9H_{20}	2,6-dimethylheptane	paraffin	135.2
35	C_8H_{10}	ethylbenzene	aromatic	136.2
36	C_9H_{18}	1,1,3-trimethylcyclohexane	cycloparaffin	136.7
37	C_8H_{10}	p-xylene	aromatic	138.4
38	C_8H_{10}	m-xylene	aromatic	139.2
39	C_9H_{20}	2,3-dimethylheptane*	paraffin	140.7
40	C_9H_{18}	1,2,4-trimethylcyclohexane	cycloparaffin	141.2
41	C_9H_{20}	4-methyloctane	paraffin	142.4
42	C_9H_{20}	2-methyloctane	paraffin	143.3
43	C_9H_{20}	3-methyloctane	paraffin	144.2
44	C_8H_{10}	o-xylene	aromatic	144.4
45	C_9H_{18}	monocyclic†	cycloparaffin	145.6
46	C_9H_{16}	bicyclic†,	cycloparaffin	146.7
47	C_9H_{20}	n-nonane	paraffin	150.7
48	C_9H_{12}	isopropylbenzene	aromatic	152.4
49	C_9H_{12}	n-propylbenzene	aromatic	159.5
50	C_9H_{12}	1-methyl-3-ethylbenzene	aromatic	161.6
51	C_9H_{12}	1-methyl-4-ethylbenzene	aromatic	162.5
52	C_9H_{12}	1,3,5-trimethylbenzene	aromatic	164.6
53	C_9H_{12}	1-methyl-2-ethylbenzene	aromatic	165.1
54	$C_{10}H_{22}$	4-methylnonane	paraffin	165.7
55	$C_{10}H_{22}$	2-methylnonane	paraffin	166.8
56	$C_{10}H_{22}$	3-methylnonane	paraffin	167.8
57	C_9H_{22}	1,2,4-trimethylbenzene	aromatic	169.2
58	$C_{10}H_{22}$	n-decane	paraffin	174.0
59	C_9H_{12}	1,2,3-trimethylbenzene	aromatic	176.1
60	$C_{11}H_{16}$	n-amylbenzene*	aromatic	204.1
61	$C_{10}H_{14}$	1,2,3,4-trimethylbenzene	aromatic	205.0
62	$C_{11}H_{16}$	1,4-dimethyl-2-propylbenzene*	aromatic	206.6
63	$C_{10}H_{12}$	5,6,7,8-tetrahydronaphthalene	aromatic-cycloparaffin	207.6
64	$C_{11}H_{16}$	1,5-dimethyl-2-propylbenzene*	aromatic	208.5
65	$C_{11}H_{16}$	1,3,5-trimethyl-2-propylbenzene*	aromatic	212.3
66	$C_{12}H_{26}$	n-dodecane	paraffin	216.3
67	$C_{10}H_8$	naphthalene	aromatic	218.0
68	$C_{12}H_{16}$	phenylcyclopentane*	aromatic-cycloparaffin	220.7
69	$C_{11}H_{14}$	2-methyl-5,6,7,8-tetrahydronaphthalene	aromatic-cycloparaffin	229.0
70	$C_{11}H_{14}$	1-methyl-5,6,7,8-tetrahydronaphthalene	aromatic-cycloparaffin	234.4
71	$C_{11}H_{10}$	2-methylnaphthalene	aromatic	241.1
72	$C_{11}H_{10}$	1-methylnaphthalene	aromatic	244.8

†Identity not yet determined. *Identity not definitely established.

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der. For example, the binary azeotropic mixtures of ethanol (78 C) with 2, 4-dimethylpentane (80.8 C), cyclohexane (80.8 C), and benzene (80.1 C) boil at about 62, 64 and 68 C, respectively. In general, aromatic hydrocarbons are easily separated from paraffins and cycloparaffins by azeotropic distillation, whereas the latter two are separated from each other with some difficulty.

The process of extraction is also used to separate hydrocarbons of about the same boiling point but of different types. As in the case of azeotropic distillation, aromatic hydrocarbons are easily separated from paraffins and cycloparaffins by efficient extraction, whereas paraffins and cycloparaffins are separated from each other with some difficulty. Three 56-ft. glass columns of about 1 cm. diameter were used on aromatic-free material of the kerosine fraction to separate paraffins from naphthenes (more soluble) by selective extraction with reflux, with methyl formate as the solvent at a temperature near 10 C. The denser solvent phase descends through an ascending stream of fine globules of the hydrocarbon phase. For solvents lighter than the hydrocarbons being separated, the flows are reversed.

The process of adsorption is mainly used at present to separate aromatic hydrocarbons from paraffins and cycloparaffins, which separation can be made quantitatively. One of the great advantages of the process is that it can be operated successfully on wide-boiling charges of material, such as the entire gasoline fraction of petroleum. This process has been used effectively, in combination with the process of distillation, to analyze the hydrocarbons in the gasoline fraction of seven different representative petroleums.

The process of crystallization is generally used to increase the purity of a hydrocarbon that has been concentrated by one or more of the other fractionating processes. The more frequently used procedure is to mix the hydrocarbon with the proper amount of a suitable solvent, take the mixture (usually by refrigeration) to a temperature that produces a "mush" or "slurry" of liquid with crystals of the wanted hydrocarbon, and then at this temperature to centrifuge the liquid from the crystals. In some cases, especially when it is sufficiently fluid near its melting point, the liquid hydrocarbon may be processed without solvent, the crystals being freed from the mother liquor by centrifuging as described heretofore.

After a given hydrocarbon has been separated from petroleum in the manner just described, a number of physical properties are measured for record and identification. These properties include the boiling point, freezing point, density, refractive index, and refractive dispersion. When the identity of the hydrocarbon is not known, determinations of the molecular weight and the carbonhydrogen content are also made. Other properties that are sometimes determined include the critical solution temperature in aniline, the viscosity, and the infrared absorption spectrum.

Any rational method of purification will leave in a hydrocarbon only those impurities that have properties close to those of the given hydrocarbon, and such impurities will tend to form an ideal solution with it. Furthermore, such impurities seldom form solid solutions with the given hydrocarbon. The ideal solution laws may, therefore, be applied to freezing and melting observations on such systems to ascertain quantitatively the amount of the unknown impurity. No property other than the freezing point can be so translated quantitatively into amount of impurity when the impurity is unknown.

The amount of impurity in the purest lot of the hydrocarbon is determined by means of time-temperature freezing and melting curves. A large number of the hydrocarbons isolated in this work have contained 0.01 or less mole fraction of impurity and some contained 0.001 or less mole fraction.

In Table 1 are listed the 72 hydrocarbons that have so far been separated from the gas, gasoline, and kerosine fractions of a Mid-Continent petroleum by API Research Project 6.

In addition to the actual isolation of pure hydrocarbons from the kerosine and more volatile fractions, considerable work has been done on the lubricant fraction of the same petroleum to produce fractions of material substantially homogeneous with respect to size and type of molecules.

In this work, the lubricant fraction was separated by distillation, crystallization, extraction, and adsorption into four broad portions: A "wax" portion, 35 per cent, which was pure hydrocarbon material and contained a considerable amount of clear oil in addition to the true wax; a "water-white" oil portion, 35 per cent, which was pure hydrocarbon material; an "extract" portion, 22 per cent, which contained, by weight, about 0.9 per cent S, 0.1 per cent N; and 0.5 per cent O; "asphaltic" portion, 8 per cent, which contained the bulk of the nonhydrocarbon components and was mostly a black solid at room temperature. The "wax" and "asphaltic" portions were not further separated, but the "water-white" oil and "extract" portions were each subjected to an exhaustive separation with respect to both size and type of molecules. A large number of final fractions substantially homogeneous with respect to size and type of molecules were obtained in this work. These final fractions were about 15 grams in size and each represented 1/40,000th part of the original crude petroleum from which it came.

As a result of correlating the properties of these final fractions with those of known hydrocarbons, the following average analysis was made with regard to the kinds of molecules in the middle of the original lubricant fraction: Normal paraffins (plus possibly a small amount of isoparaffins), 18 to 26 per cent, naphthenes or cycloparaffin hydrocarbons with 1, 2, or 3 rings per molecule, 51 to 43 per cent; mixed cycloparaffin-aromatic hydrocarbons with 1 aromatic ring and, in the same molecule, 1, 2, or 3 cycloparaffin rings, 8.3 per cent; mixed cycloparaffin-aromatic hydrocarbons with 2 aromatic rings (condensed as in naphthalene) and, in the same molecule, 2 cycloparaffin rings, 8.1 per cent; mixed cycloparaffin-aromatic hydrocarbons with 3 aromatic rings (condensed) and, in the same molecule, 1 cycloparaffin ring, 6.6 per cent; "asphaltic" constituents, 8 per cent. The striking part of this analysis of the lubricant fraction is the absence of any significant amount of purely isoparaffin hydrocarbons, and, except in the "asphaltic" portion, of any purely aromatic hydrocarbons.

The researches necessary to carry on a petroleum chemical industry whose purpose is substantially that of achieving a more economic utilization of petroleum, may logically be divided into two groups: Fundamental research and applied researches. The fundamental researches include the investigation of the chemical constitution of petroleum and the determination of the physical and thermodynamic properties of hydrocarbons and their derivatives, and the study of the mechanisms of their reactions. The applied researches include the development of practical commercial methods for effecting the separation of wanted hydrocarbons and their derivatives from petroleum and petroleum products, and the investigation of various chemical reactions involving petroleum hydrocarbons and their derivatives for the purpose of obtaining new and desirable substances. The fundamental researches should be carried on and encouraged in the university and government laboratories, leaving the competitive research and development units of the industry to make practical application of the knowledge and data obtained by the nonprofit laboratories. The system should be a self-perpetuating one wherein the industry, profiting from its applications of the basic knowledge and data, would be anxious to assure the continued flow into the proper channels of resources for researches on base-line problems. ★★★

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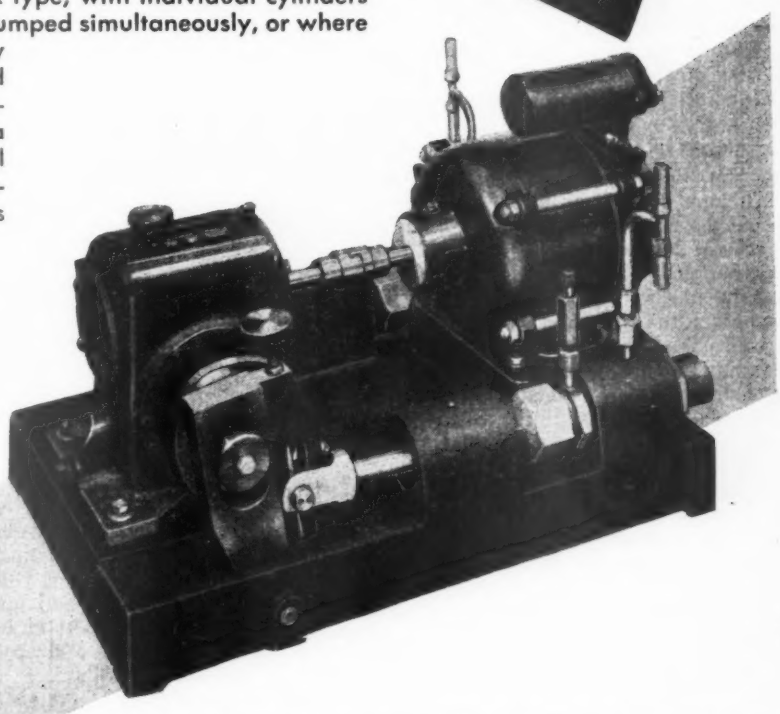

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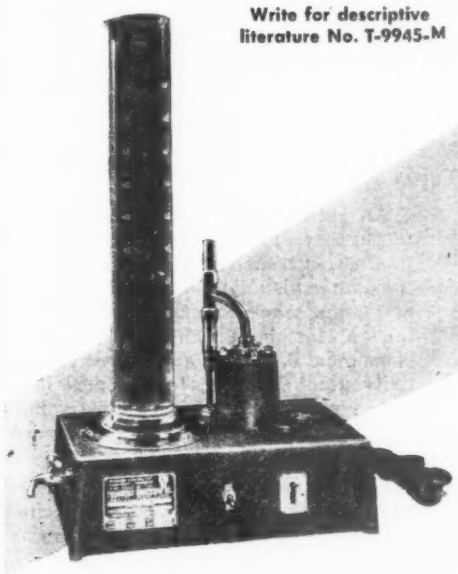

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The gas industry in 1946*

By **R. H. HARGROVE,**† *President,* American Gas Association

THE gas industry completed the year 1946 with an enviable record. On the one hand it demonstrated its traditional stability and soundness by passing through the difficult reconversion period without losing a step in its march of progress. All-time records were established in every category of the industry with the exception of industrial sales, which levelled off from wartime peaks, reflecting general unsettled business conditions. On the other hand, the industry's vitality and determination to advance was made crystal clear by the industry's great postwar research and promotional program—an effort of unprecedented magnitude in the 130-year history of the industry. More people used gas than ever before and more innovations in gas appliances appeared on the market than in any year in the past decade. In short, it was a banner year, auguring well for the future prosperity of the industry.

● **Statistics.** At the close of the year, customers of the gas utility companies reached a new high of 20,835,000, an increase of 2.7 per cent over 1945. Of this number, 9,401,000 consumers received natural gas, 8,973,000 were served with manufactured gas, and 2,461,000 used mixed gas. In addition, the rapidly expanding liquefied petroleum gas industry accounted for an estimated more than 5,000,000 customers in the rural territories beyond the town gas mains.

Total industry revenues of the utility gas industry aggregated $1,205,992,000, an increase of 4 per cent as compared with the previous year. Most substantial increases occurred in the residential and commercial classifications while industrial revenues maintained their high 1945 levels.

Natural gas revenues were more than $705,000,000, an increase of 3.4 per cent, whereas revenues from manufactured gas jumped 5.6 per cent over 1945 to approximately $392,000,000. Mixed gas returns advanced 2.4 per cent to a total of $109,000,000.

Sales of natural gas, totaling 2,192,778,000 M cu. ft., were slightly greater than in the previous year, with substantial increases being recorded in residential and commercial gas. Manufactured gas sales were 412,053,000 M cu. ft. or 4.2 per cent higher, and mixed gas sales advanced 3.7 per cent to 145,832,000 M cu. ft. In both instances, residential and commercial gas registered gains of approximately 8 per cent compared with 1945.

Although, generally speaking, the gas industry's progress has been widely held to have been steady but unspectacular, a comparison of 1946 figures with those of a decade ago reveals significant if not startling advances. The gas industry, not including the LP-Gas branch, has gained 26.6 per cent in total consumers attached to its lines, 77 per cent in sales volume and 57 per cent in total revenues.

Indicative of the rapid growth anticipated, it is estimated that in the four years, 1946 to 1949 inclusive, the gas utility industry will add 2,535,000 new customers (not including the LP-Gas industry). Further, it is calculated that during this four-year period construction expenditures will be $653,323,000 for physical plant extension; $278,413,000 for ordinary maintenance expenditures; and $14,430,500 for house piping materials—a grand total of $946,168,500.

● **Natural gas expansion.** The natural gas industry in the past decade has grown at an accelerated pace. It now serves an area with a population of 41 million in 33 states using a network of 220,000 miles of trunk lines and mains with a total production of 4 trillion cu. ft. including other than utility sales, and a market value of 850 million dollars. It has advanced from 41 to 48 per cent in the number of customers served by the whole gas industry. Total assets are more than 4 billion dollars.

Approval of new long distance pipeline construction continues at a rapid pace. A new 1200-mile line from Texas to California with a capacity of 305 million cu. ft. per day is now being built at a cost of 70 million dollars. Other pipeline projects approved and under way this past year involve a total additional mileage of 2640 miles and an expenditure of 120 million dollars.

The impending disposal by the government of the "Inch" pipe lines from Texas to the northeast has excited a lively interest on the part of the manufactured gas industry in the latter area in the economic possibilities of natural gas as a raw material in the manufactured gas process. A natural gas supply to large metropolitan areas of the northeast may come in the near future.

Proved recoverable reserves of natural gas in the United States as of December 31, 1945, were approximately 148 trillion cu. ft., the American Gas Association's committee on natural gas reserves has reported, thus indicating an ample supply to meet the stepped-up demand for many years to come.

Development of synthetic gasoline from natural gas that appears to be competitive with gasoline produced from petroleum is a notable recent event. A huge plant is being erected in Texas for this purpose and others are contemplated.

Also noteworthy is the increasing recognition of the chemical values represented by natural gas and its products. During the last decade a rapidly increasing chemical development, based on petroleum hydrocarbons, has occurred and the present trend is toward greatly increased utilization of the natural hydrocarbons as raw materials and intermediates. According to chemical experts, this spectacular trend reflects the growing realization by oil and gas companies and chemical companies that the natural hydrocarbons are ideal raw materials for synthetic chemicals.

The natural gas investigation sponsored by the Federal Power Commission held an important spotlight. Regional hearings were completed at Washington on August 2 after seven hearings in various parts of the country. More than 14,000 pages of testimony with over 450 exhibits were submitted by 314 expert witnesses from state and federal commissions and bureaus, the gas, coal, and railroad industries, labor unions and others. This record will form the basis of FPC recommendations to the 1947 Congress.

● **Research and promotional plan.** The American Gas Association's Research and Promotional Plan, launched October 1, 1944, has been the main motivating force responsible for the gas industry's rapid progress immediately following the war. Gas company subscriptions totaling more than $1,600,000 per year, in addition to the regular association budget, are being expended for research, promotion, and advertising.

An entirely new field of endeavor in the history of the association is the gas production research feature of the industry plan, which calls for the discovery of better and cheaper methods of producing gas for the benefit of the ultimate consumer. Partly as a result of this activity, plant capacities to meet peak loads in the manufactured gas industry have been increased an estimated 35 per cent over the past two years.

A great deal has been accomplished in developing greater plant capacities through the reforming of hydrocarbon gases and by other equipment and process modifications. Pilot plant tests have been arranged on catalytic reforming of certain sulphur-free raw materials to produce blue gas, and the full possibilities of mixing a variety of gases in the interest of greater plant capacities are being further explored.

Much time has been devoted to the task of determining which new gas production processes offer sufficient promise

*Gist of year-end summary released by American Gas Association.

†Mr. Hargrove is vice president and general manager of United Gas Pipe Line Company, Shreveport, Louisiana.

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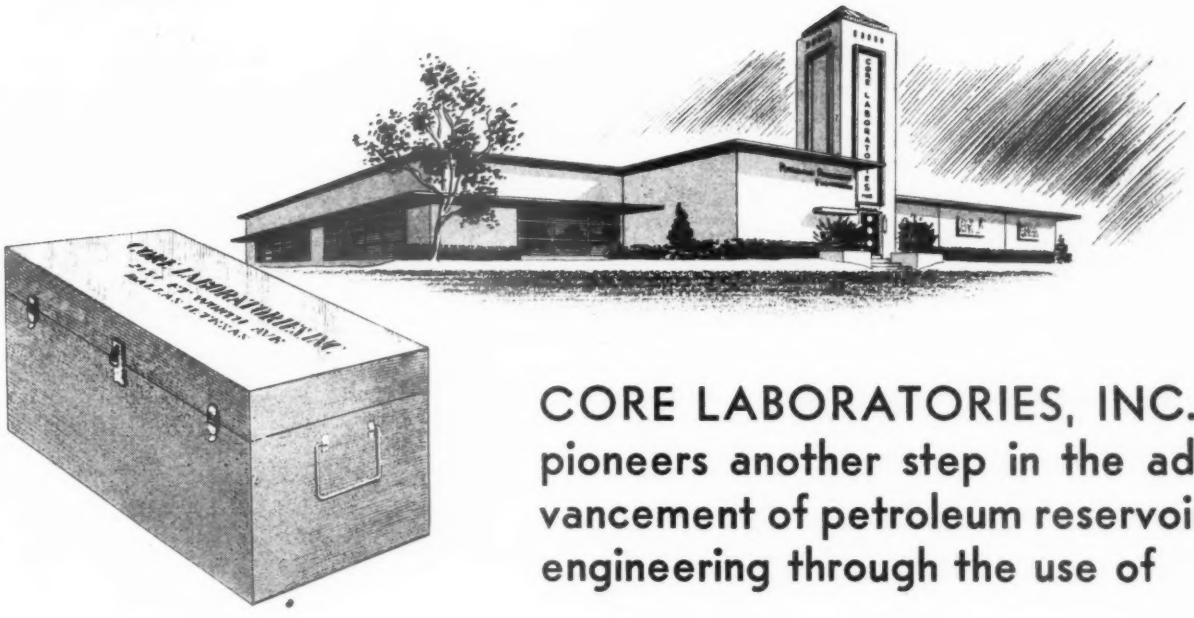

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All types of gas (preliminary estimates).

Consumers	1946	1945	Per cent change
Total	20,835,000	20,292,000	+ 2.7
Residential	19,449,000	18,996,000	+ 2.4
Commercial	1,283,000	1,197,000	+ 7.2
Industrial	89,000	85,000	+ 4.7
Other	14,000	14,000	..
Revenues			
Total	$1,205,992,000	$1,159,478,000	+ 4.0
Residential	762,887,000	722,030,000	+ 5.7
Commercial	149,845,000	140,591,000	+ 6.6
Industrial	279,503,000	278,026,000	+ 0.5
Other	13,757,000	18,861,000	−27.1

Natural gas (preliminary estimates).

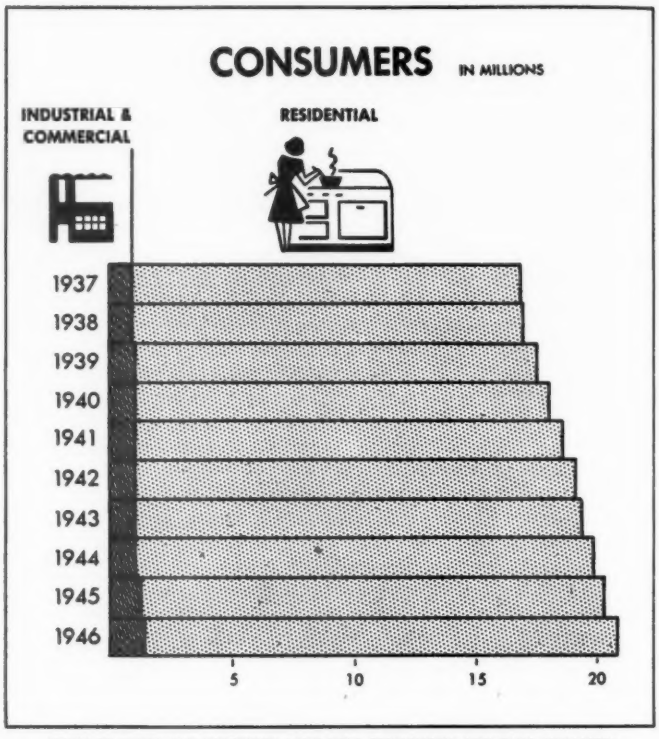
Consumers	1946	1945	Per cent change
Total	9,401,000	9,054,000	+ 3.8
Residential	8,737,000	8,443,000	+ 3.5
Commercial	624,000	572,000	+ 9.1
Industiral	35,000	34,000	+ 2.9
Other	5,000	5,000	..
Sales in M. cu. ft.			
Total	2,192,778,000	2,179,080,000	+ 0.6
Residential	612,928,000	567,514,000	+ 8.0
Commercial	177,873,000	167,783,000	+ 6.0
Industrial	1,336,921,000	1,319,300,000	+ 1.3
Other	65,056,000	124,483,000	−47.7
Revenues			
Total	$ 705,222,000	$ 682,224,000	+ 3.4
Residential	384,403,000	365,400,000	+ 5.2
Commercial	77,511,000	73,822,000	+ 5.0
Industrial	233,300,000	228,202,000	+ 2.2
Other	10,008,000	14,800,000	−32.4

Manufactured gas (preliminary estimates).

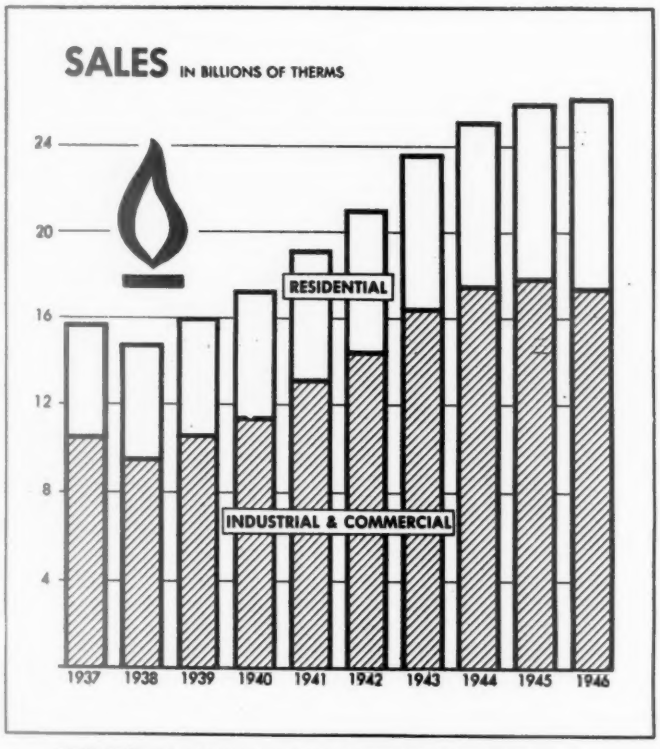
Consumers	1946	1945	Percent change
Total	8,973,000	8,803,000	+ 1.9
Residential	8,394,000	8,254,000	+ 1.7
Commercial	532,000	504,000	+ 5.6
Industrial	39,000	37,000	+ 5.4
Other	8,000	8,000	..
Sales in M. cu. ft.			
Total	412,053,000	395,483,000	+ 4.2
Residential	280,659,000	260,135,000	+ 7.9
Commercial	66,107,000	60,492,000	+ 9.3
Industrial	60,231,000	69,396,000	−13.2
Other	5,056,000	5,460,000	− 7.4
Revenues			
Total	$ 391,864,000	$ 370,939,000	+ 5.6
Residential	296,028,000	277,498,000	+ 6.7
Commercial	58,582,000	53,719,000	+ 9.1
Industrial	33,931,000	36,212,000	− 6.3
Other	3,323,000	3,510,000	− 5.3

Mixed gas (preliminary estimates).

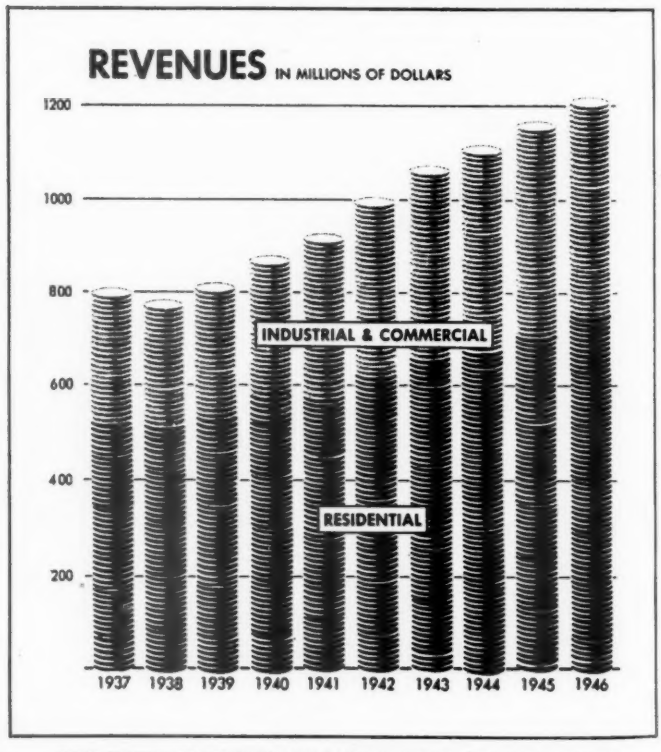
Consumers	1946	1945	Percent change
Total	2,461,000	2,435,000	+ 1.1
Residential	2,318,000	2,299,000	+ 0.8
Commercial	127,000	121,000	+ 5.0
Industrial	15,000	14,000	+ 7.1
Other	1,000	1,000	..
Sales in M. cu. ft.			
Total	145,832,000	140,619,000	+ 3.7
Residential	97,881,000	90,576,000	+ 8.1
Commercial	21,432,000	19,877,000	+ 7.8
Industrial	25,583,000	28,798,000	−11.2
Other	936,000	1,368,000	−31.6
Revenues			
Total	$ 108,906,000	$ 106,315,000	+ 2.4
Residential	82,456,000	79,102,000	+ 4.2
Commercial	13,752,000	13,050,000	+ 5.4
Industrial	12,272,000	13,612,000	− 9.8
Other	426,000	551,000	−22.7



TREND OF UTILITY GAS CONSUMERS (1945 DATA PRELIMINARY; 1946 DATA ESTIMATED)



TREND OF UTILITY GAS SALES (1945 DATA PRELIMINARY; 1946 DATA ESTIMATED)



TREND OF UTILITY GAS REVENUES (1945 DATA PRELIMINARY; 1946 DATA ESTIMATED)

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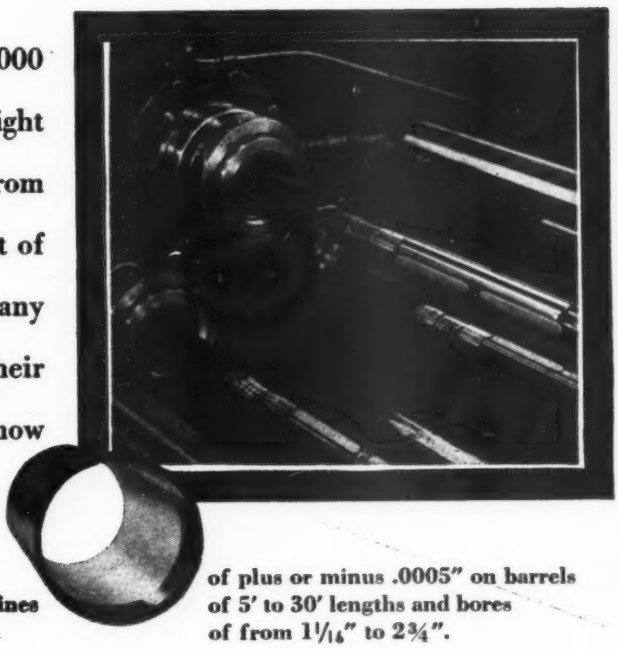
***Did you know that only eight years ago the industry said*— "It is impossible to hone for more than twelve inches with any degree of accuracy..."**

THAT WAS EIGHT YEARS AGO–100,000 one-piece steel barrels ago. In those eight years, you production men have purchased from Fluid Packed Pump Company 1,000,000 feet of precision honing–Fluid Packed Pump Company built the machines – your acceptance of their production has proved that twelve inches is now only one foot of an accurately honed barrel.



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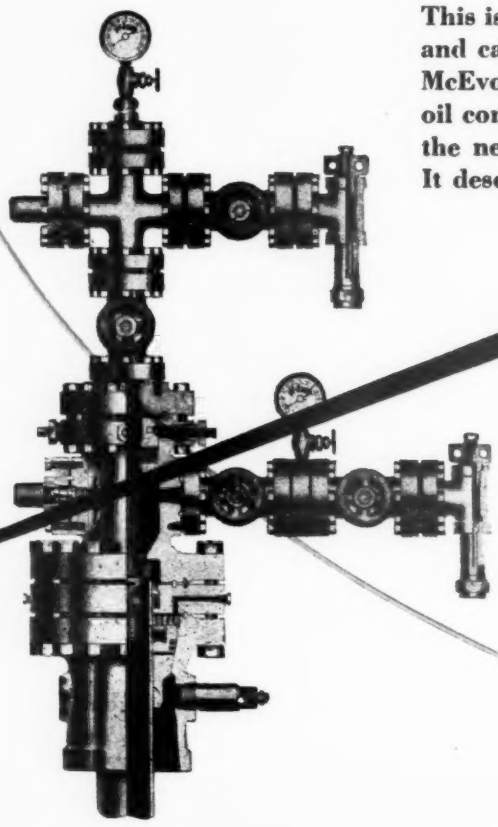
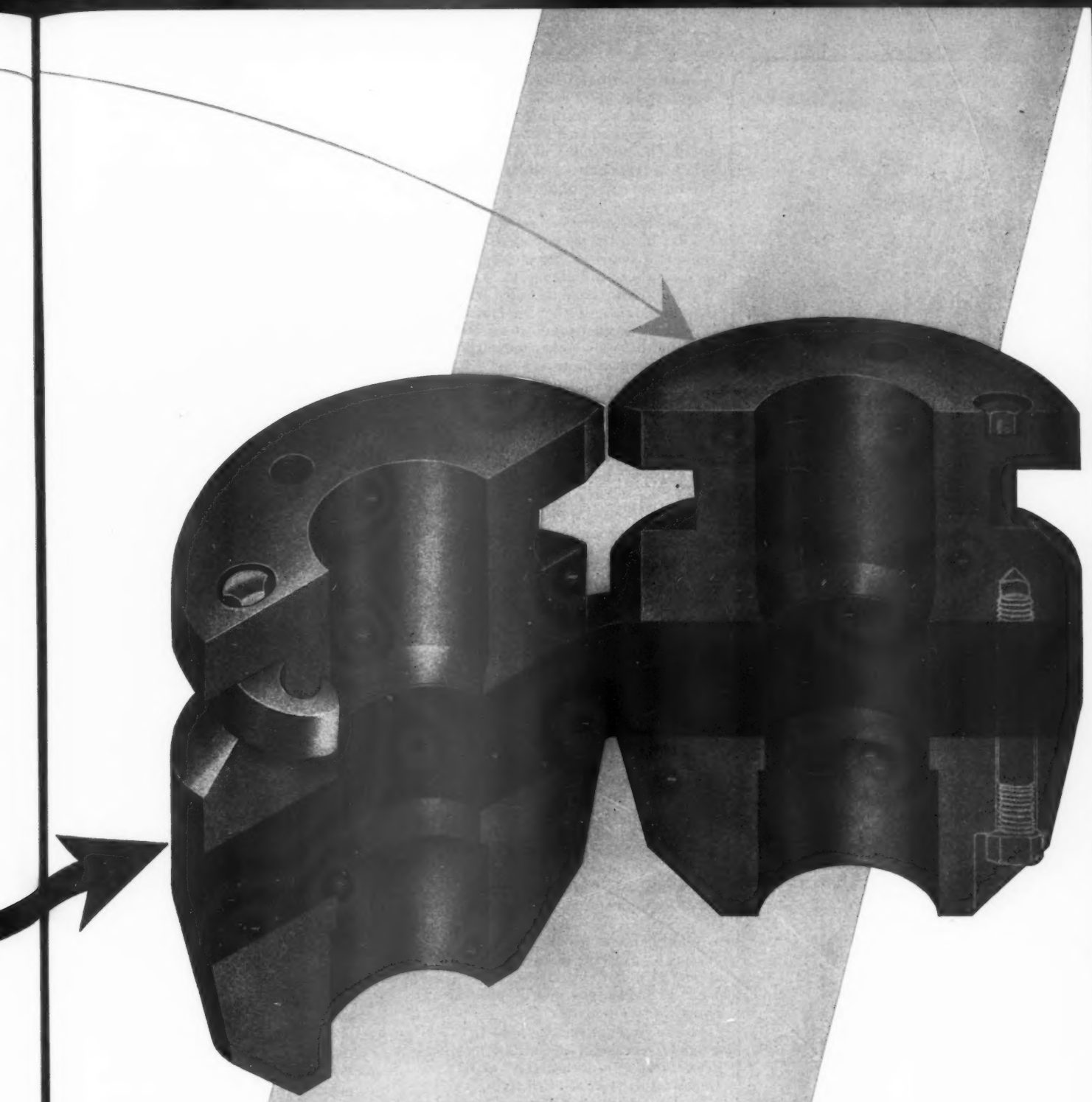


This is just one of many interchangeable tubing and casing hangers that have made McEvoy Well Heads the favorite of leading oil companies. Write for your copy of the new McEvoy Catalog. It describes them all.

Left: The Type AG-1 Tubing Hanger is shown in an XT-158 Dual Completion Well Head assembly. This hanger fits any well head assembly with a Type A or A-1 Tubing Head.



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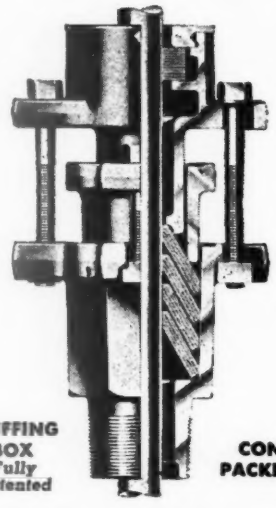

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to justify further research on a laboratory or pilot plant scale. Of those investigated, the fluidization process is being further explored on a laboratory research basis. The possibility of using high coke oil in a regenerative oil gas set for the production of a high Btu gas is also scheduled for an early plant scale test. The analysis of the components of water gas tar in order to improve its dehydration and treatment and upgrade its commercial value is under way.

Basic studies have included laboratory determinations of the fundamental reactions between oxygen-steam and carbon, and between steam and carbon, and a search for sulphur-resistant catalysts.

● **Utilization research.** The gas industry, through the AGA, has under way a comprehensive research program designed to improve domestic, industrial and commercial utilization and to develop new uses for gas. This work is carried on in close cooperation with the manufacturers of gas appliances and equipment.

Domestic gas research is furthered by analyzing the fundamental technical position of each present and proposed use of gas in the home, and assigning definite research projects to outstanding organizations in connection with each use. In addition, the gas flame is literally being torn apart in the laboratory to bring out every scientific factor that has a bearing on its efficiency and heating ability under conditions of use. Controls, safety devices, and accessories are being thoroughly analyzed to bring out their maximum effectiveness.

Research projects in this program include cooking, water heating, space heating, summer air conditioning, venting, and burners, controls and accessories. In every one of these fields, there is a steady and noticeable improvement in appliances, equipment, and installation practices. Not only have new designs of standard appliances, which incorporate appealing and useful features, made their appearance, but entirely new uses of gas are being made possible by postwar appliance developments.

In carrying out the gas industry's program of research, specialized technical projects have been assigned to Battelle Memorial Institute, Columbus; Case School of Applied Science, Cleveland; Institute of Gas Technology, Chicago; Arthur D. Little, Inc., Cambridge; Purdue Research Foundation, Lafayette, and the AGA Testing Laboratories, Cleveland. Coordination is through technical advisory groups of outstanding gas company and appliance manufacturer engineers.

Pursuing a course of investigation in the field of natural gas comparable to work done in manufactured gas production, a report on the interchangeability of other fuel gases with natural gases has been published. Data covering the performance of appliances adjusted for natural gas when various kinds of supplemental gas mixtures are employed has been plotted to provide operators with quick and ready means of obtaining necessary factors for interchanging gas fuels for peak loads.

Other projects cover a variety of subjects ranging from exploration of new methods for the application of gas to cooking through the range of industrial and commercial uses to the possibilities of storing natural gas in hydrate form.

● **Industrial and commercial gas.** Many new uses for industrial gas that were developed during the war are now in service in the processing of products made of metal and other materials. Industries using heat in their manufacturing processes, and there are few indeed that do not, have come to look to gas as the premier industrial fuel for accuracy and quality of performance as well as speed and labor saving. These factors are well exemplified in the recently-designed gas furnaces, ovens, and special industrial gas equipment. These include large paint drying and finishing ovens for automobile body drying, radiant gas burners for ceramic furnaces, and high-speed direct flame heat-treating.

Commercial gas sales reached an all-time high during the past year, due largely to the increase in cooking in public eating places. Gas cooks more than 90 per cent of the 62 million meals that are served daily in hotels and restaurants. Some of the new models of heavy duty equipment serving this profitable market are being produced in stainless metal alloys offering longer life, more attractive appearance, and ease of cleaning.

● **Technical developments.** The AGA continued to sponsor technical conferences covering gas production, chemical, distribution, and motor vehicle practices. It also carried on many technical research projects, published engineering handbooks and manuals, issued safe practice pamphlets, and generally contributed to the advancement of gas operating techniques.

A development of interest to the technical men was the introduction on an experimental basis of plastic tubing for gas service piping as a substitute for conventional metallic pipe. At least one large gas utility completed extensive tests on such gas arteries and reported promising results.

The use of radio for prompt communication in emergencies and for other purposes is increasing steadily. In 1944, less than 30 gas companies were using this modern vehicle, whereas early in 1946 it was found that 57 gas companies were using this form of communication.

● **Conclusion.** It is evident from this brief summary that the gas industry has increased its stature as a vital factor in the nation's economy and in the everyday lives of the people. Its record is one of constructive achievement and its pipe lines to the future are strong indeed. We have passed the 1946 milestone and look forward confidently to the next. ★★★

★★★★★★

A new estimate places the natural-gas reserves of the United States at 144.2 trillion cubic feet. This is the fuel equivalent of almost 24 billion barrels of oil.

Quick freezing seals fluid content in cores

By **JOHN D. WISENBAKER,*** Core Laboratories, Inc.

● **Introduction.** For many years cores have been cut from oil and/or gas-bearing formations and analyzed for porosity, permeability, oil and water saturation, and other properties in order to obtain data for application toward: (1) Better well completion, (2) more accurate estimation of recoverable oil and gas, and (3) more efficient production of petroleum reservoirs.

J. D. Wisenbaker

The pore space in an oil-bearing formation is normally filled with interstitial (connate) water, and oil with its dissolved gas. During drilling operations where water base mud is the drilling fluid, a water front precedes the cutting face of the bit and displaces formation oil, reducing the oil saturation to a quantity normally found after effective water drive. The pore space in a core, before it is raised from the bottom of the well, is filled with oil and its dissolved gas, connate water, and drilling water that has displaced formation oil. As the core is raised to the surface the gas in solution in the residual oil expands as pressure declines, and forces part of the drilling fluid from the pore space of the core. Upon arrival at the surface, the pore space is occupied by residual oil, connate water, drilling fluid, and void space created by the expanding gas.

The above process is sufficiently consistent for any fixed set of reservoir conditions so that measurements for oil and water saturation, permeability, and porosity, made on a fresh core immediately after it reaches the surface, can be used to interpret accurately the type and quantity of production to be expected and, together with other data, to calculate accurately the amount of recoverable oil and/or gas in the reservoir.

On reaching the surface the core, due to capillarity, ordinarily begins to absorb water from the drilling mud, and on exposure to the atmosphere begins losing oil and water by evaporation. These effects result in a substantial deterioration in value of a delayed analysis.

For several years it has been common practice to place a laboratory at the well site in order to provide immediate analysis on fresh cores. This practice occupies the full time of a field crew, and limits the service of each laboratory to one well at a time.

A research project was initiated for the development of a method to provide reliable analysis on fresh cores without the necessity of having a field laboratory at the well site except in cases where immediate results of analysis are needed to direct coring schedules or to aid in well completion.

● **General.** Out of this research has come the development of a method for preserving the fluid content of fresh cores by quick freezing. The application of quick freezing was believed to be a practical method of preserving the fluid content of cores because freezing effectively anchors each particle of oil and water in that particular part of the core that it occupies on being taken from the well. Some concern was felt, however, on what effect quick freezing might have on permeability, porosity, and other physical characteristics of oil and gas-bearing rock. A drastic alteration of the sample was not expected because the particles of water are dispersed throughout the core and the expansion due to freezing is cushioned by oil and gas content of the core. Porosity was not expected to change appreciably because, even with considerable interval fracturing that might cause a substantial change in permeability, no solid matter would be added or removed.

● **Changes in permeability and porosity caused by quick freezing consolidated sand cores fully saturated with water.** A maximum change in permeability and porosity was expected by quick freezing samples fully saturated with water, because the expanding ice would not have void space, which is usually present in fresh cores taken from oil or gas bearing formations, to accommodate any appreciable expansion.

With these considerations in mind, samples of sand were selected from several different oil fields for the purpose of determining changes in permeability and porosity caused by quick freezing samples fully saturated with water.

Twenty-five cylindrical samples of consolidated sand, 2 cm in diameter and

TABLE 1. Permeability and porosity values measured on identical consolidated sand samples fully saturated with water before and after quick freezing.

Permeability in millidarcys		Porosity, per cent	
Before freezing	After freezing	Before freezing	After freezing
138	164	19.4	19.9
4.50	8.93	19.1	20.5
335	352	16.3	16.5
3.60	7.06	17.8	19.1
5.00	7.83	16.5	17.0
5.36	9.30	19.2	20.1
117	132	23.0	23.5
36	38	17.2	17.4
15	17	14.3	14.6
450	457	16.8	16.9
25	27	13.1	13.3
151	160	21.1	21.2
303	313	18.7	18.6
101	103	14.4	14.9
557	561	20.6	20.6
921	940	21.9	21.7
118	120	20.3	20.5
36	54	23.2	23.4
14	14	11.4	11.4
33	36	23.0	23.0
1.32	1.40	04.5	04.8
10.1	10.6	14.9	14.9
2.63	4.40	16.3	16.0
0.099	0.110	03.3	03.7
16	32	24.7	24.2
Av. 136	143	17.24	17.51

TABLE 2. Permeability and porosity values measured on identical samples of consolidated sand partially saturated with gas before and after quick freezing.

Sample no.	Gas saturation	Permeability in millidarcys		Porosity, per cent	
		Before freezing	After freezing	Before freezing	After freezing
1	55.8	2.68	2.67	9.48	9.32
2	64.0	3.77	4.15	8.29	8.22
3	55.1	3.51	3.76	9.55	9.50
4	47.5	29	28	11.50	11.48
5	45.2	7.05	6.58	10.45	10.44
6	25.4	102	99	21.80	21.80
7	27.5	325	338	21.80	21.80
8	36.4	42	43	13.76	13.60
9	27.9	80	79	18.61	18.50
10	44.6	188	198	14.19	14.15
11	24.9	1529	1542	21.00	12.70
12	29.5	100	101	18.70	18.50
13	32.0	1839	1970	19.20	19.30
Average	39.7	324	340	15.25	15.18
1	9.75	2.67	2.59		
2	11.2	4.15	3.85		
3	11.8	3.76	3.92		
4	11.7	28.5	29		
5	10.9	6.58	7.12		
6	15.5	99	99		
7	14.6	338	361		
8	23.0	43	45		
9	17.8	79	83		
10	9.15	198	213		
11	16.3	1542	1595		
12	18.7	101	104		
13	17.2	1970	2010		
Average	14.4	340	351		
1	0	2.59	2.82		
2	0	3.85	3.90		
3	0	3.92	5.25		
4	0	29	30		
5	0	7.12	8.00		
6	0	99	102		
7	0	361	359		
8	0	44	44		
9	0	83	83		
10	0	213	217		
11	0	1595	1427		
12	0	104	101		
13	0	2010	2030		
Average		351	340		

*The author was graduated from S.M.U. in 1939 with a B.S. degree in M.E. He was employed by Core Laboratories, Inc. as a field engineer in core analysis and bottom hole sample and pressure work until September, 1942. At this time he entered the U. S. Navy where he served 41 months as an engineering officer in the submarine service. Since his release in January, 1946, he has been employed in Core Lab's research department and has worked on relative permeability and capillary pressure apparatus, and the development of new techniques and equipment relative to petroleum reservoir engineering.

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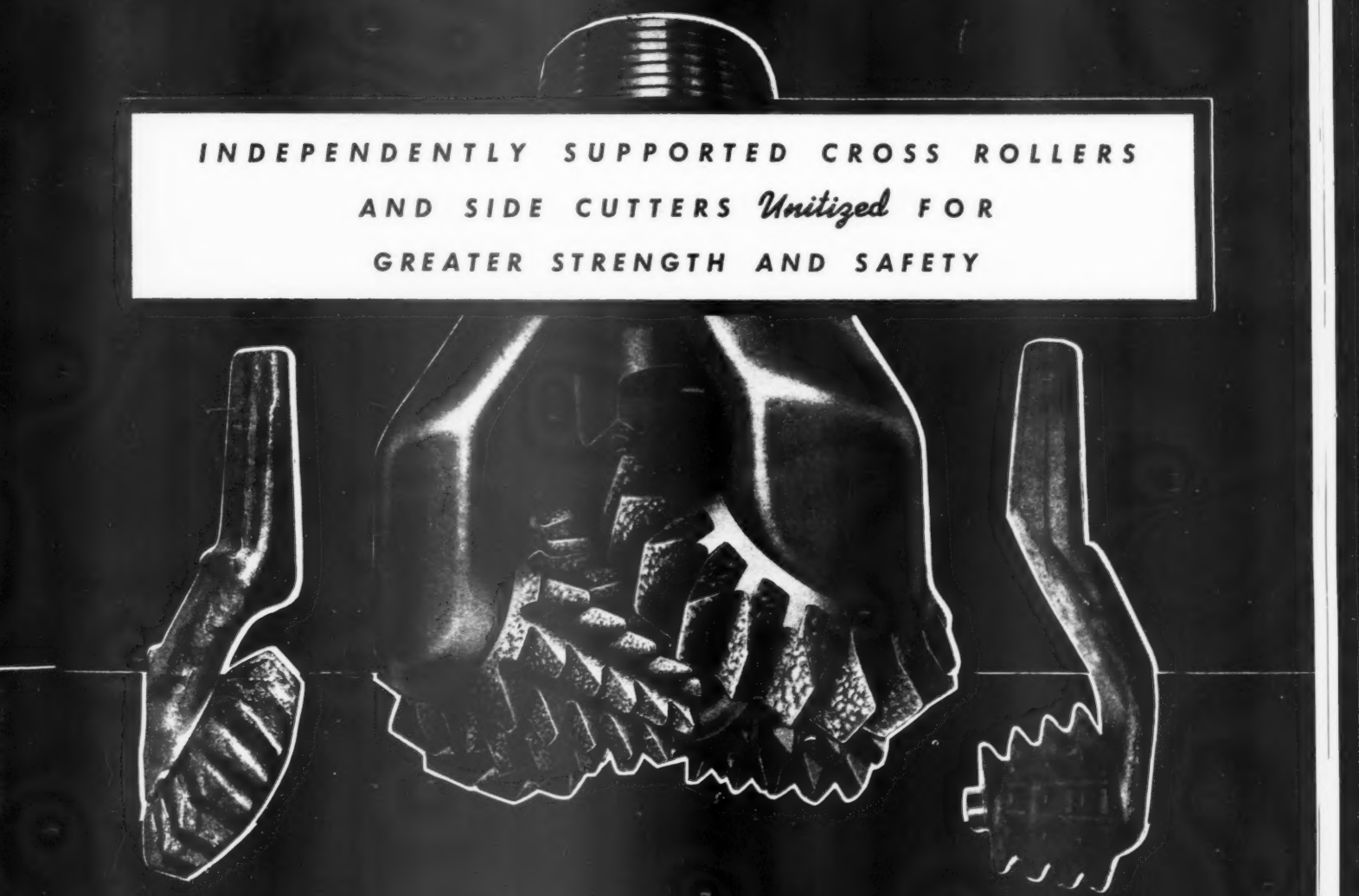

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TABLE 3. A comparison of average permeability before and after quick freezing for samples with various average gas saturations.

Permeability range	Total no. samples	Average gas saturation, per cent pore	Average permeability in millidarcys		
			Before freezing	After freezing	Per cent change
Permeability less than 10 millidarcys	11	0	2.66	5.36	47.3
Permeability more than 10 millidarcys	27	0	293	294	0.35
Permeability less than 10 millidarcys	4	10.9	4.29	4.37	1.86
Permeability more than 10 millidarcys	9	16.0	489	504	3.06
Permeability less than 10 millidarcys	4	55	4.25	4.29	0.94
Permeability more than 10 millidarcys	9	32.8	512	525	2.54

TABLE 4. A comparison of average porosity values before and after quick freezing consolidated sand samples fully and partially saturated with water.

No. of samples	Average gas saturation	Porosity, per cent pore		
		Before freezing	After freezing	Per cent change
25	0	17.21	17.51	1.74
13	39.7	15.25	15.18	—0.46

approximately 2 cm long, with a permeability ranging from a fraction of a millidarcy to several hundred millidarcys, were selected. The samples were extracted by positive flushing with carbon tetrachloride and dried at 280 F. Permeability measurements were made by direct measurement of rate of air flow. Samples were weighed accurately, evacuated, saturated with distilled water, and re-weighed for porosity determinations. Care was taken at all times to protect the saturated samples from the atmosphere by keeping them sealed in weighing bottles. The samples were wrapped in a single layer of paper and covered with several inches of dry ice and allowed to remain frozen for 16 hr. The samples were removed from the dry ice, thawed, and dried. Permeability and porosity determinations were again made in the manner already described.

The porosity and permeability of each sample measured before and after quick freezing is shown in Table 1.

● **Changes in permeability and porosity caused by quick freezing consolidated sand cores partially saturated with gas.** Most cores from oil and gas-bearing formations reach the surface partially saturated with gas. In view of this fact, it was thought advisable to determine the change in permeability and porosity caused by quick freezing samples of this type. Thirteen consolidated sand samples were selected from various oil fields for this purpose.

TABLE 5. A comparison of average data for permeability, porosity, oil and water saturation for four wells taken from well site analysis and from subsequent analysis data for frozen samples.

Well designation	No. of samples analyzed	Average permeability		Average porosity		Average oil saturation		Average total water saturation	
		Regular analysis	Frozen samples	Regular analysis	Frozen samples	Regular analysis	Frozen samples	Regular analysis	Frozen samples
Well A	12	111	125	24.1	26.5	12.6	11.8	53.6	58.2
Well B	22	167	175	17.2	17.5	16.2	16.1	37.0	38.7
Well C	20	22.3	22.7	17.8	18.2	13.0	11.5	45.4	44.7
Well D	37	26.0	24.9	19.1	19.5	23.2	24.2	41.2	38.7
Overall weighted average		70.5	73.9	19.0	19.7	17.9	17.8	42.7	42.6

Permeability and porosity measurements were made as described earlier. Samples were saturated with water, weighed, and exposed to the atmosphere until part of the water in the pore space of the sample had evaporated. Gas saturations were determined by weighing. The cores were then frozen for approximately 20 hr., thawed, and dried, and permeability measurements were again made. Samples were re-saturated and porosity determinations were made in the usual manner.

The above procedure was repeated twice with decreasing gas saturations in an effort to compare permeability and porosity values before and after quick freezing for several gas saturations.

No appreciable change of porosity was observed with the completion of the first set of porosity measurements on samples partially saturated with gas, as was the case on the first 25 samples that were fully saturated with water. Consequently, porosity was not measured during the last two experiments. The gas saturation was zero on the last experiment.

Tabular data for these measurements are shown in Table 2.

A comparison of permeability values below 600 md, before and after quick

FIG. 1

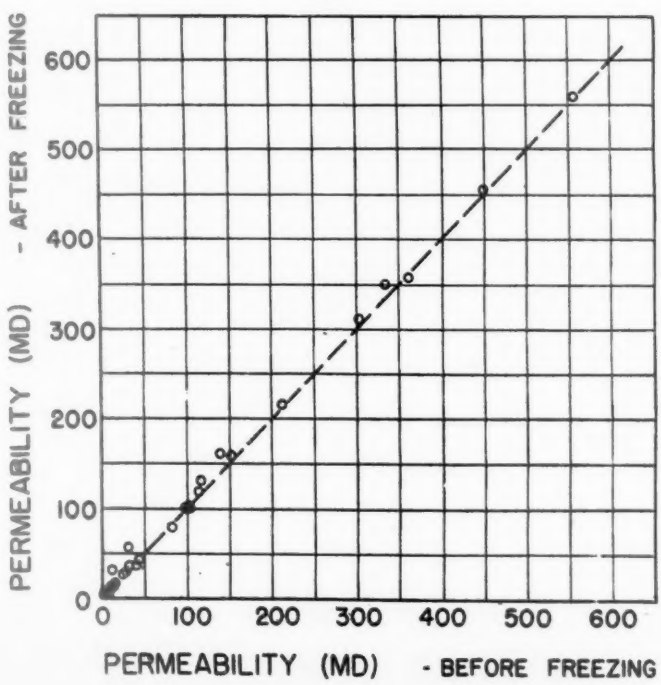
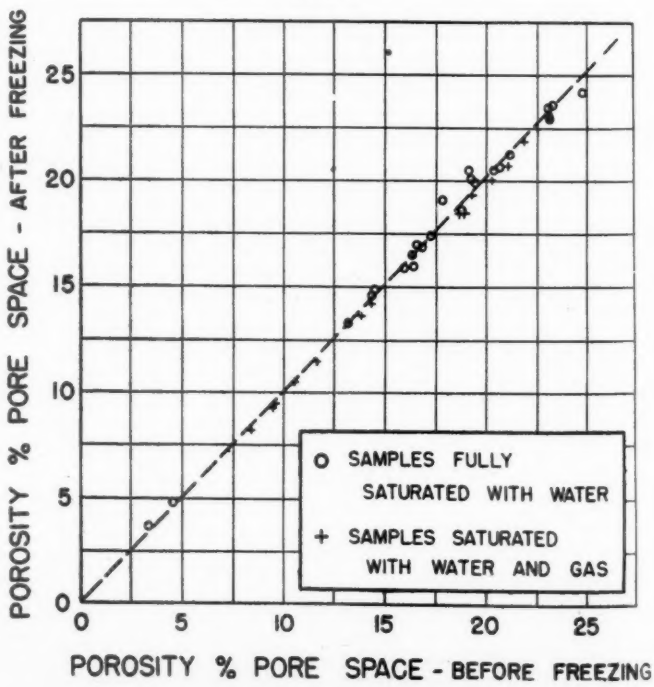
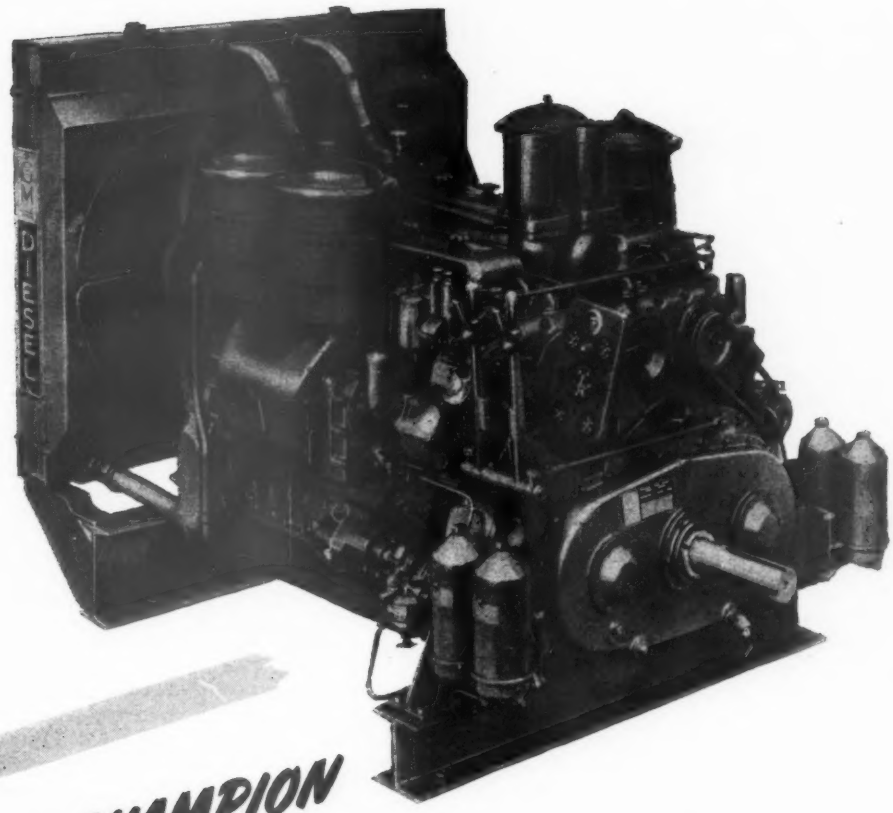


FIG. 2





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freezing samples fully saturated with water is shown graphically in Fig. 1.

A comparison of porosity values before and after quick freezing for samples fully and partially saturated with water is shown graphically in Fig. 2.

Permeability values from Tables 1 and 2 were grouped according to permeability range and gas saturation, and average permeability values were calculated for samples with more than and less than 10 millidarcys for various average gas saturations. These data are shown in Table 3.

Average values in Table 3 indicate the following changes may be expected by quick freezing core samples paritally or fully saturated with water:

1. Samples fully saturated with water and with permeability less than 10 millidarcys show an average increase in permeability of 47.3 per cent.

2. The permeability of samples with less than 10 millidarcys and with 10.9 per cent average gas saturation show an average increase of 1.86 per cent.

3. Samples fully saturated with water with permeability of more than 10 millidarcys show an average increase in permeability of 0.35 per cent.

4. Samples with more than 10 millidarcys and average gas saturations of 16.0 per cent and 32.8 per cent show an average increase in permeability of 3.06 per cent and 2.54 per cent, respectively.

The decreased effect of freezing on samples with more than 10 per cent gas saturation may possibly be due to the fact that water expands approximately 9 per cent on freezing.

Porosity values from Tables 1 and 2 were grouped according to gas saturation. All samples with no gas saturation were averaged as a group, and all samples having gas saturation were averaged as a separate group. The average porosity values for each group before and after freezing are shown in Table 4.

A study of the above table indicates:

1. Porosity on samples with zero gas saturation shows an average increase of 1.74 per cent of porosity.

2. Porosity on samples with an average gas saturation of 38 per cent shows an average decrease of 0.46 per cent of porosity.

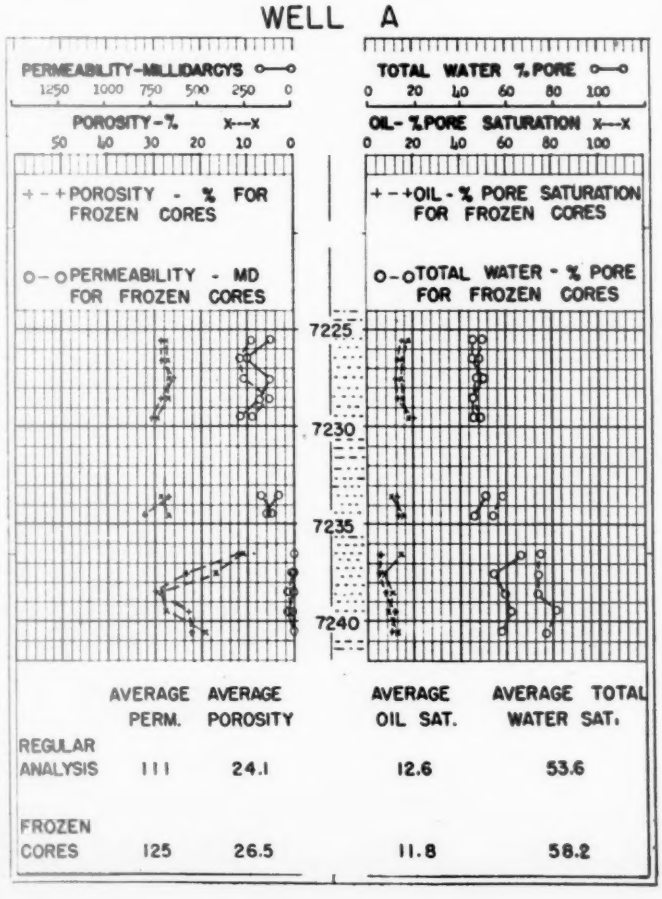
● **Changes in permeability, porosity, oil and water saturation, caused by quick freezing fresh sand cores.** No appreciable change in permeability and porosity was observed from determinations made on samples partially and fully saturated with water before and after quick freezing. It was then decided to compare results of permeability, porosity, oil and water saturation measurements obtained from well site analysis on fresh cores with results obtained on samples selected as nearly representative as possible to those analyzed at the well after they had been frozen for an appreciable length of time.

Four wells were selected for this purpose—one on the Texas Gulf Coast, two in the Mid-Continent area, and one in California.

It was thought advisable to split each core through the longitudinal axis, use one half for the well site analysis, and freeze the other half for subsequent analysis.

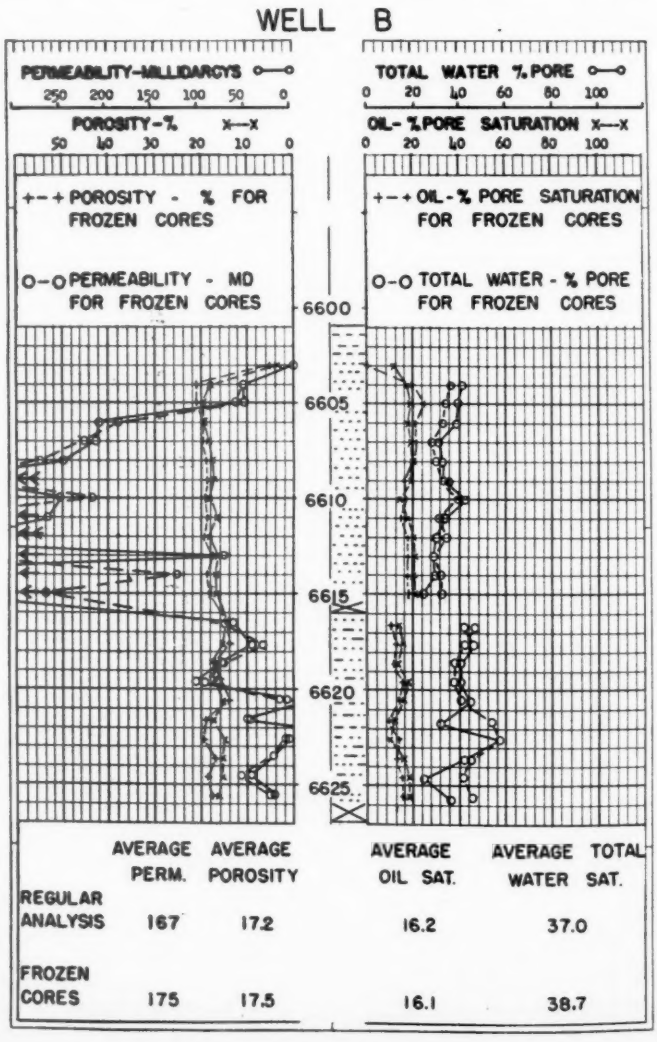
The first cores analyzed were those of the well in the Texas Gulf Coast area. The wire line cores taken in this case were too small to permit the selection of two samples from the same piece of core. Adjacent samples therefore were selected from the same foot of core. One part was analyzed in the field laboratory immediately after being taken from the well. The adjacent part was cleaned of drilling mud and promptly wrapped in a single layer of paper, on which was marked the depth from which it was selected, placed in an insulated box, covered with several inches of dry ice, and allowed to remain frozen for approximately 20 hr. Twelve samples were frozen in this manner. All samples were removed from the freeze box at the same time and exposed to the atmosphere. Frost, which quickly collected on the surface of each sample, was removed from pieces of core selected for water determinations by brushing with a fiber brush.

FIG. 3


WELL A
PERMEABILITY-MILLIDARCYS
1250 1000 750 500 250 0
POROSITY-%
50 40 30 20 10 0
+ - + POROSITY - % FOR FROZEN CORES
o - o PERMEABILITY - MD FOR FROZEN CORES
TOTAL WATER % PORE
0 20 40 60 80 100
OIL-% PORE SATURATION
0 20 40 60 80 100
+ - + OIL - % PORE SATURATION FOR FROZEN CORES
o - o TOTAL WATER - % PORE FOR FROZEN CORES
7225
7230
7235
7240

	AVERAGE PERM.	AVERAGE POROSITY	AVERAGE OIL SAT.	AVERAGE TOTAL WATER SAT.
REGULAR ANALYSIS	111	24.1	12.6	53.6
FROZEN CORES	125	26.5	11.8	58.2

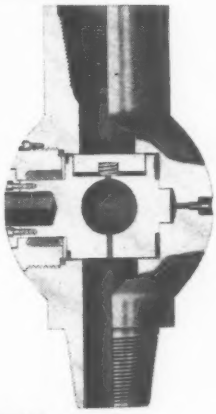
FIG. 4


WELL B
PERMEABILITY-MILLIDARCYS
250 200 150 100 50 0
POROSITY-%
50 40 30 20 10 0
+ - + POROSITY - % FOR FROZEN CORES
o - o PERMEABILITY - MD FOR FROZEN CORES
TOTAL WATER % PORE
0 20 40 60 80 100
OIL-% PORE SATURATION
0 20 40 60 80 100
+ - + OIL - % PORE SATURATION FOR FROZEN CORES
o - o TOTAL WATER - % PORE FOR FROZEN CORES
6600
6605
6610
6615
6620
6625

	AVERAGE PERM.	AVERAGE POROSITY	AVERAGE OIL SAT.	AVERAGE TOTAL WATER SAT.
REGULAR ANALYSIS	167	17.2	16.2	37.0
FROZEN CORES	175	17.5	16.1	38.7

2 SHAFFER SAFEGUARDS

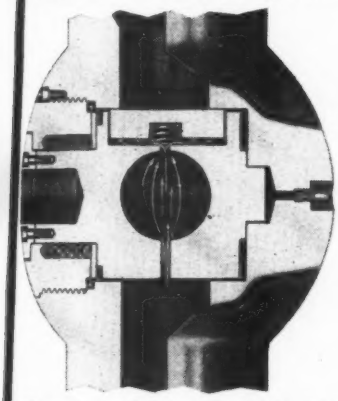
To protect the neglected "danger spot" at the top of your drill string...



Did you ever stop to think that, even though your cellar is equipped with the most advanced safety equipment for shutting off against blow-outs around the *outside* of your drill string, you are wide open for a blow-out through the *inside* unless you're equipped with a positive *foolproof* means of closing off the top of the drill string? For this job you need the specially-engineered features of the . .

SHAFFER KELLY COCK

Perfected by the same organization that developed the famous Shaffer Cellar Control Gates, here are some of the important advancements the Shaffer Kelly Cock offers . . .



BALANCED COMPACTNESS:

Unlike clumsy, heavy control valves, the Shaffer Kelly Cock is compact, streamlined and balanced to prevent wobble and off-center gyration of the Kelly at even the highest rotational speeds.

EASY-TURNING, NO "FREEZING"

Unlike conventional types of plug valves, the Shaffer Kelly Cock is specially engineered to assure quick, easy operation at all times, *together with pressure-tight sealing efficiency.* Note in illustration at left how the Kelly Cock is designed with a "floating" disc only slightly larger than the circulation hole. This small floating disc cuts frictional drag to a minimum, assuring easy operation.

But when the Kelly Cock is closed, as well pressure increases inside the drill string this pressure is applied against the bottom of the disc as shown at left, thus tightly sealing the disc over the circulation hole to prevent any leakage. The higher the pressure the tighter the seal!

PROTECTS SWIVEL AND ROTARY HOSE

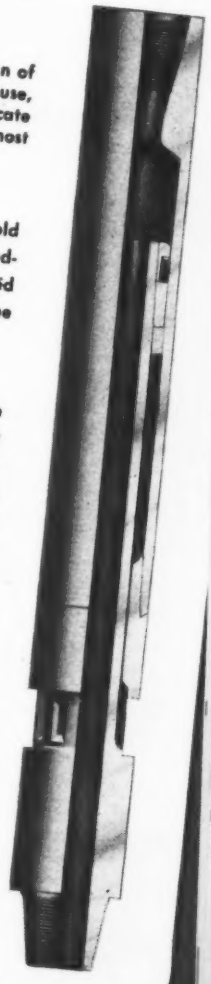
The Shaffer Kelly Cock is threaded with box up and pin down to be placed between Kelly and Swivel, thus safeguarding the Rotary Hose and Swivel packing against rupture or damage from blow-out pressures. It is available in a complete range of sizes for 3½", 4½", 6⅝" and 7⅝" Kellys. Write today for complete details on this important safety item!

... and to protect your drill string against "danger spots" at the bottom!

Here's an important Shaffer safety item for the lower end of your drill string to protect against "balling up" of the bit, tight spots, heaving formations and other dangerous conditions that may stick your drill string. It's the . . .

SHAFFER DRILLING BUMPER SUB

And it offers a lot of important features that make it ideal for modern high speed drilling conditions. For example . . .



MAXIMUM SIMPLICITY:

Note the unusually simple and rugged design of the Shaffer Drilling Bumper Sub. It's simple to use, simple to maintain and has no complicated or delicate parts to break or get out of adjustment under the most rugged drilling operations.

FOOLPROOF PACKING:

The packing unit is not only designed to hold the highest drilling pressures, but has the added advantage that it can be quickly inspected and serviced with the Sub right in the table by simply breaking one joint and raising the upper portion a few inches.

UP OR DOWN BLOWS:

By simple manipulation of the drill string the Shaffer Drilling Bumper Sub can be made to deliver both upward and downward blows—with striking force under complete control at the surface—to loosen "balled up" bits, stuck drill pipe from key seats, etc. It is ready for operation within seconds from the time the pipe sticks—before cuttings have had a chance to settle or drill string become wedged in place.

PASSES WIRE LINE INSTRUMENTS

The Shaffer Drilling Bumper Sub is designed to be run in the drill string—directly above drill collars, reamers, or other tools that are apt to become stuck, and in all but the smallest sizes has sufficient internal diameter to permit running standard wire line tools, core barrels and similar equipment. It is available in a complete range of sizes to fit all popular drill strings. Get all the details on this valuable safeguard from your nearest Shaffer shop—or by writing direct.

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
CASPER, WYOMING, Mountain Sales and Service, 133 North Wolcott Street
EXPORT SALES OFFICE: Shaffer Tool Works, 30 Rockefeller Plaza, New York, N. Y., U. S. A.

After preparing approximately half of the samples for analysis the frost previously noticed on the surface of the remaining samples was observed to have thawed, indicating that the temperature of the outside of each sample had risen above the freezing point. The remaining samples selected for water content determination were wiped with a dry cloth but a considerable amount of water was absorbed by the partially thawed surface of each sample. The effects of water thus collected by the last several samples was quite noticeable in the final analysis results. Total water saturation measured on frozen and non-frozen samples is in fairly close agreement for the first few samples, but diverges in the last samples. A graph of permeability, porosity, oil and total water saturation versus depth from well site analysis and from analysis of frozen cores are shown in Fig. 3.

Wells B and C, in the Mid-Continent area, were cored with conventional barrels that cut cores 3½ in. in diam. From both wells a piece of core approximately 4 in. long was selected from each foot, carefully cleaned of drilling mud, and split through the longitudinal axis. One-half the core was analyzed immediately at the well site in a portable field laboratory for permeability, porosity, oil and water saturation, and the other half wrapped in a single layer of paper and placed in an insulated box beneath several inches of chipped dry ice. Care was taken to mark the correct depth represented by each sample on the sample wrapper. The particular section of each sample selected for permeability, porosity, oil and water saturation for the well site analysis was suitably marked opposite the point selected on the half taken for freezing in order to assure representative samples for the second analysis.

The frozen samples from wells B and C were analyzed approximately 30 hr. after freezing. In each case, laboratory equipment and technique employed were, as nearly as possible, identical to that used for well site analysis. Cores were removed from the freeze box singly and prepared for analysis, thus preventing any partial thawing of the sample surface. Care was taken to remove all frost from samples selected for the determination of water saturation.

Values for permeability, porosity, oil and total water saturation are plotted versus depth for the well site analysis and the analysis of the frozen samples in

FIG. 5

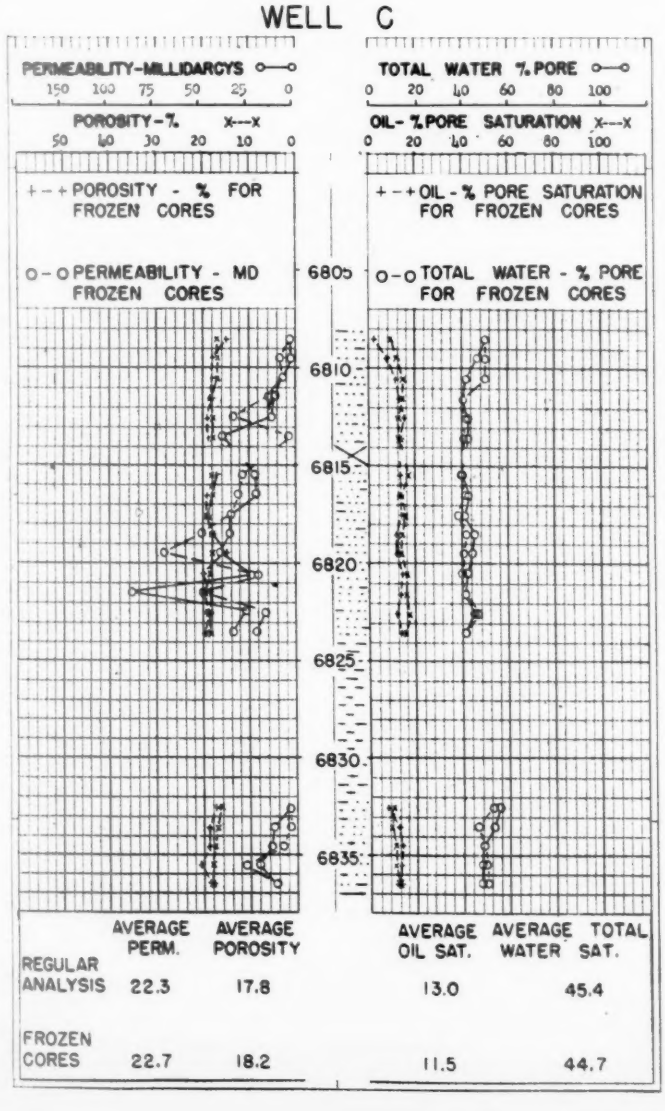
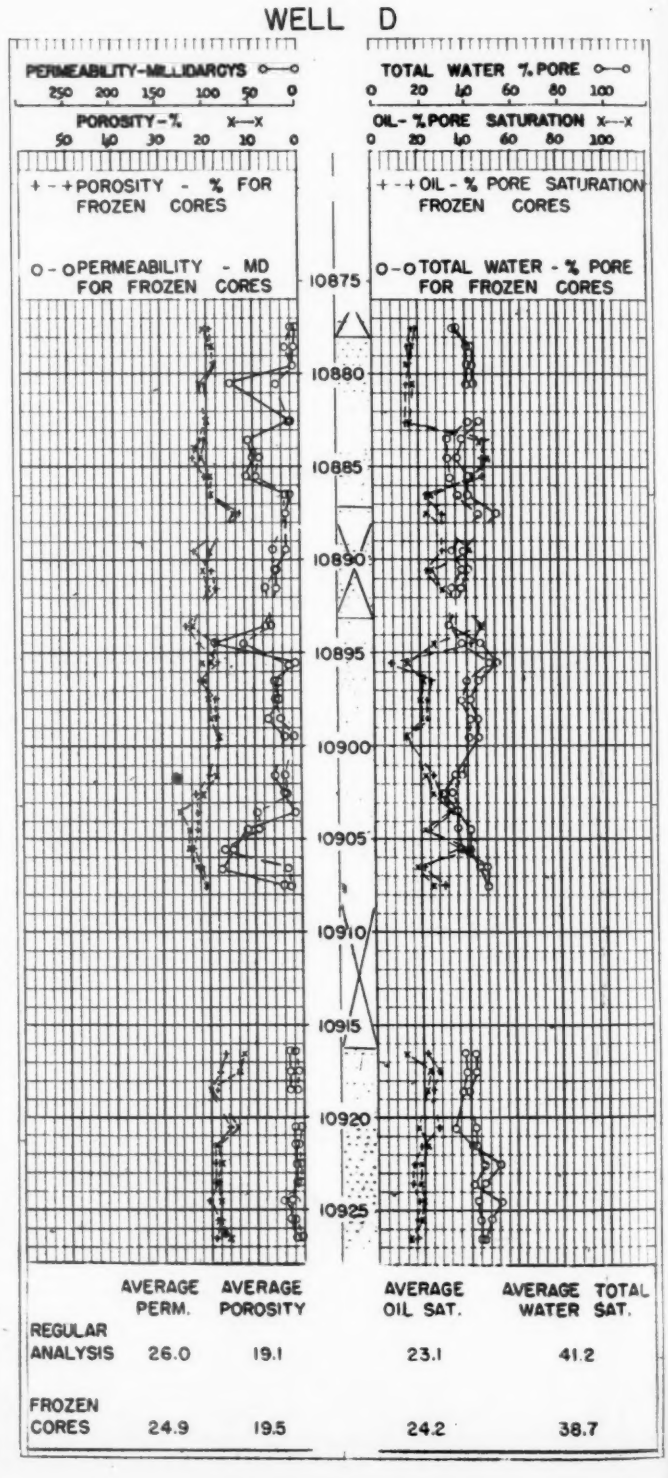
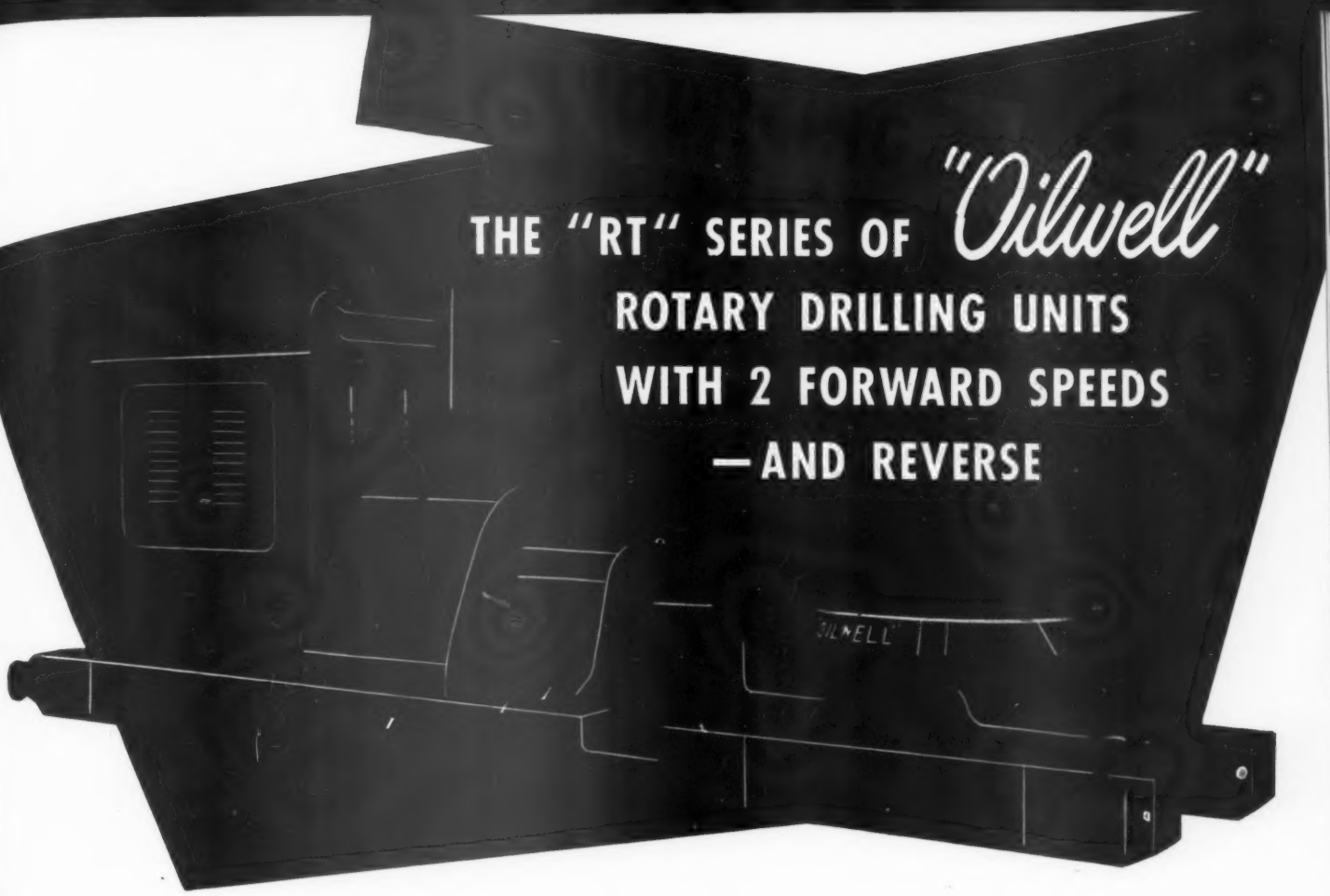

WELL C
PERMEABILITY-MILLIDARCYS
150 100 75 50 25 0
POROSITY-%
50 40 30 20 10 0
+ - + POROSITY - % FOR FROZEN CORES
O - O PERMEABILITY - MD FROZEN CORES
TOTAL WATER % PORE
0 20 40 60 80 100
OIL-% PORE SATURATION
0 20 40 60 80 100
+ - + OIL - % PORE SATURATION FOR FROZEN CORES
O - O TOTAL WATER - % PORE FOR FROZEN CORES
6805
6810
6815
6820
6825
6830
6835
AVERAGE PERM.
AVERAGE POROSITY
AVERAGE OIL SAT.
AVERAGE TOTAL WATER SAT.
REGULAR ANALYSIS 22.3 17.8 13.0 45.4
FROZEN CORES 22.7 18.2 11.5 44.7

FIG. 6



THE "RT" SERIES OF "Oilwell" ROTARY DRILLING UNITS WITH 2 FORWARD SPEEDS —AND REVERSE



OVER SIX YEARS AGO, "Oilwell" originated and introduced the first rotary drilling unit—with rotary independently driven by an internal combustion engine through a torque converter and gear box. Since that time, a large number of these units (known as the "CT" series) have been placed in service.

Today, "Oilwell" Rotary Drilling Units are known throughout the world for the smoothness, flexibility and high degree of drill-string control which they have brought to rotary operations on mechanical rigs.

NOW—"OILWELL'S" SERIES "RT" DRILLING UNITS
(Fitting Companions to the "CT" Series)
GIVE YOU ADDITIONAL PERFORMANCE FEATURES

TWO FORWARD SPEEDS—These new units are equipped with a special gear box which provides instant selection of gear ratios in keeping with formations encountered. This permits a wider range of rotary operations within the high efficiency performance range of the prime mover and torque converter.

BUILT-IN REVERSE—This feature makes "RT" Units particularly adaptable for fishing and clean-out work where selection can be made for clockwise and counter-clockwise rotation as required.

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Los Angeles, California

UNITED STATES STEEL

SPECIFICATIONS

"Oilwell" Rotary Drilling Unit	CT-1715C	CT-1715D	CT-2015	RT-1717C	RT-1717D	RT-2017
"Oilwell" Rotary	17½-A	17½-B	20½	17½-A	17½-B	20½
Speed Ratios: Rotary	3.28:1	3.28:1	3.82:1	3.28:1	3.28:1	3.82:1
Gear Case (Speed Increaser)	1:1.44	1:1.44	1:1.44	1:1.31	1:1.31	1:1.31
"RT" Gear Case (Speed Decrease)	.....	.....	.....	1.68:1	1.68:1	1.68:1
"RT" Gear Case (Reverse)	.....	.....	.....	1.48:1	1.48:1	1.48:1
Dimensions: Height, Over-all	7'4"	7'4"	7'4"	7'4"	7'4"	7'4"
Length, Over-all	20'0"	20'0"	20'0"	21'4"	21'4"	21'4"
Width, Across Skids	4'3¼"	4'3¼"	4'3¼"	4'3¼"	4'3¼"	4'3¼"
Weight, Complete Less Rotary Drive Bushing:						
Domestic .....pounds	18,260	18,370	18,820	18,300	18,410	18,930
Export .....pounds	19,660	19,870	20,220	19,800	19,910	20,430

For Complete Information Request the Following Bulletins

R9-1046 — "Oilwell" Rotary Drilling Units, "CT" Series

R10-1046 — "Oilwell" Rotary Drilling Units, "RT" Series

OIL WELL SUPPLY COMPANY · USS · UNITED STATES STEEL

"OILWELL"

Anglo-American expands research

The Anglo-American Oil Company announced in London, England, at the first of the year the formation of a new petroleum research organization to expand the work of its British laboratories.

Shareholders in the company, to be known as the Esso Development Company, Ltd., are the Anglo-American Oil Company and Standard Oil Development Company, which operates the American laboratories of Standard Oil of New Jersey. The company has an authorized capital of £200,000 ($800,000).

This is another instance of the trend toward scientific and technical exploration that has been evident in the petroleum industry in the last decade or so. The war years accelerated interest to a high degree. Most projects in the research division have been undertaken in the United States but the trend is also decided in Great Britain.

Figs. 4 and 5. Average data are shown at the bottom of each figure.

Samples from well D were selected from a well in California in the same manner as described above. The cores were frozen at the well site and packed with approximately 75 lb. of dry ice in an insulated box, then shipped to Core Laboratories, Dallas, Texas, where they were kept frozen for 30 days. The samples were then removed from the freeze box and analyzed as described.

Values for permeability, porosity, oil and total water saturation for well site analysis and the frozen cores versus depth are plotted graphically in Fig. 6. Average values are listed on the lower part of the figure.

In Table 5 is a summation of average data for the four wells from which cores were frozen for subsequent analysis and comparison with results from well site analysis.

The samples selected for freezing from well A are not thought to be representative in comparison to those analyzed at the well because the small diameter core made it necessary to select the sample for freezing immediately below or above the one used for well site analysis. Also, as pointed out earlier in this article, the surface of the last several samples was allowed to thaw and absorb water collected from the atmosphere, thereby increasing the water saturation beyond the amount normally measured.

The results from the analysis of frozen cores selected from well B, C, and D are in very close agreement with values measured by well site analysis.

● **Summary.** Permeability and porosity measurements have been made on consolidated sand cores, selected from various oil fields, before and after quick freezing. The measurements were made on samples with gas saturation varying from zero to approximately 55 per cent.

No appreciable change in porosity was caused by quick freezing samples fully or partially saturated with water. No appreciable change in permeability was noticed for samples for 10 per cent or more gas saturation. Samples fully saturated with water, but with a permeability of more than 10 millidarcys, showed no substantial change due to quick freezing. Samples fully saturated with water and with permeability of less than 10 millidarcys showed some change in permeability.

Fresh core samples adjacent to those analyzed at the well were frozen and analyzed at times varying from 20 hours to 30 days after freezing. No appreciable change in permeability, porosity, oil or water saturation due to quick freezing was in evidence.

It is concluded that physical characteristics and fluid content of cores can be preserved almost indefinitely by quick freezing fresh samples when they are taken from the well.

In Figs. 3, 4, 5, and 6, permeability, porosity, oil, and total water saturations from well site analysis and from subsequent analysis of frozen samples are plotted versus depth for four oil wells.

★★★

ROCKFORD

OVER

CENTER

CLUTCHES

EASY OPERATION
HIGH TORQUE
POSITIVE ENGAGEMENT *
LARGE DRIVING AREA
SMOOTH RUNNING
INFREQUENT ADJUSTMENT
MINIMUM INERTIA

* ROCKFORD Over-Center CLUTCHES remain in or out of engagement until changed by the operator. The smooth, easy, anti-friction engagement — obtained by roller cams pressing against the pressure plate face — progresses from "release" to "on center" to slightly "over center" where the clutch locks in engaged or running position.

Send for This Handy Bulletin

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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ROCKFORD CLUTCH DIVISION BORG-WARNER
1303 Eighteenth Avenue, Rockford, Illinois, U.S.A.

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It takes lots of slide rule slipping and drawing pencils to be a good engineer. But after a while the answers come easier.

The answers that make Jensen Pumping Units right for modern production are the result of 27 years engineering and manufacturing experience.

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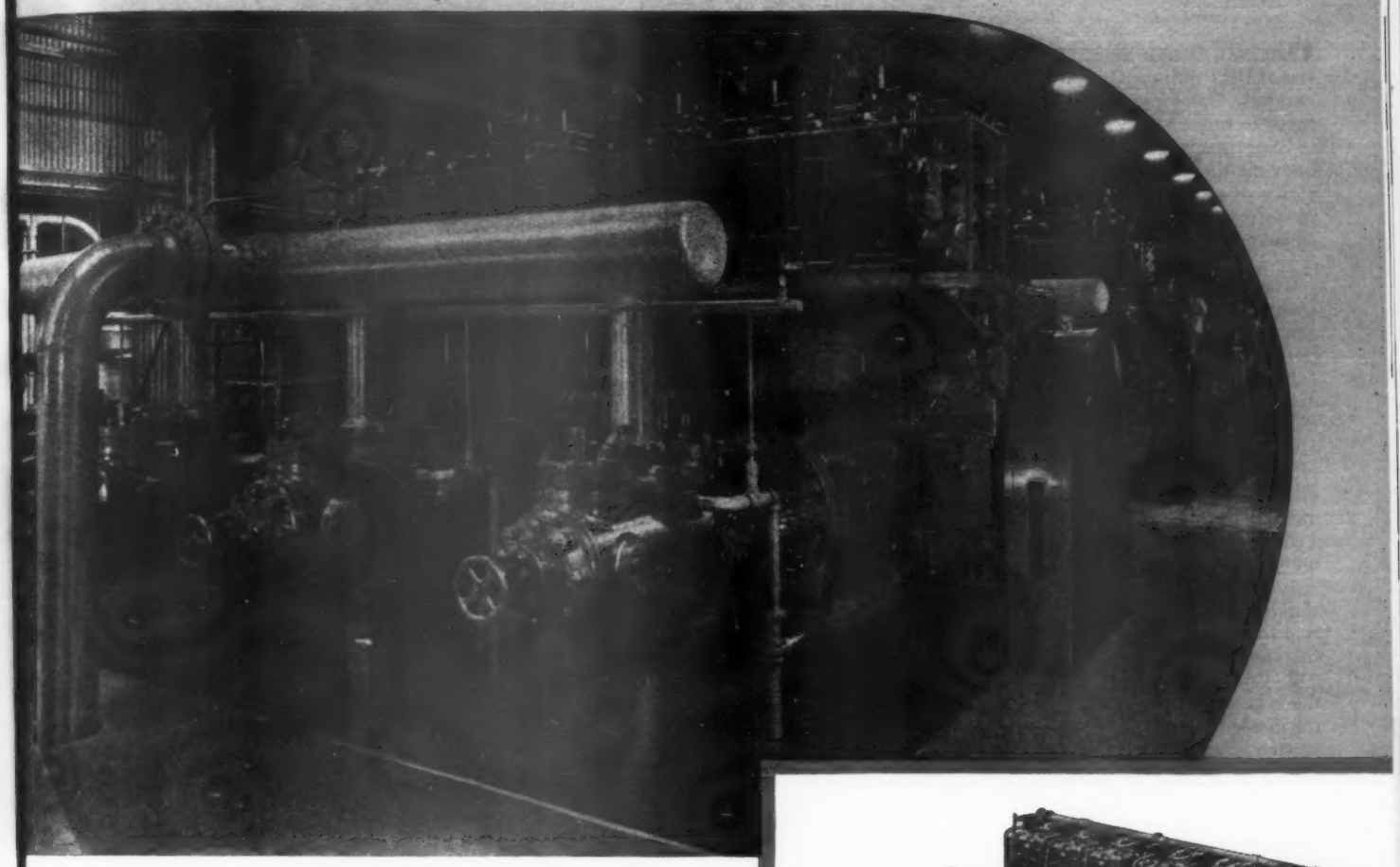
Most horsepower per unit of space



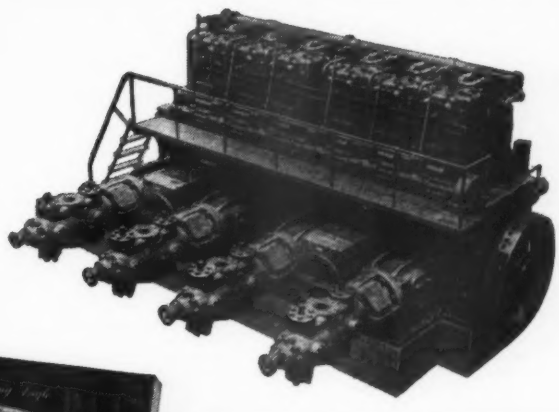
Clark 1200-BHP "Big Angle" Compressors in the Tennessee Gas and Transmission Pipe Line Company's station at Winchester, Ky.

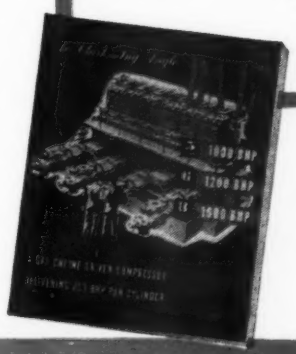
● This is the king of the heavy-duty compressor field, the new Clark BA-17 Right Angle Compressor.

The BA-17 represents the highest development of the long line of Clark 2-Cycle gas-engine-driven compressors. It was designed to fill the need for greater economy in high pressure pipe line pumping and large scale pressure maintenance.

It doubles the horsepower per cylinder previously available in gas-engine-driven compressors—200 BHP instead of 100 BHP—the most compact, heavy-duty compressor ever built.

This results in much lower foundation and building costs and lower maintenance costs.





For complete specifications and data on the BA-17, including typical installation design for modern pipe line station, ask for Catalog BA-17.

CLARK BROS. CO. INC., OLEAN, NEW YORK

New York • Tulsa • Houston • Chicago • Boston • Washington • Los Angeles
London • Buenos Aires • Caracas, Ven. • Basrah, Iran

New fluid catalytic cracker design

ORIGINAL design features developed by the engineers of Universal Oil Products Company, and proved out in a new type fluid catalytic cracking pilot plant, foreshadow substantial advantages to refiners by making the cracking reaction more efficient.

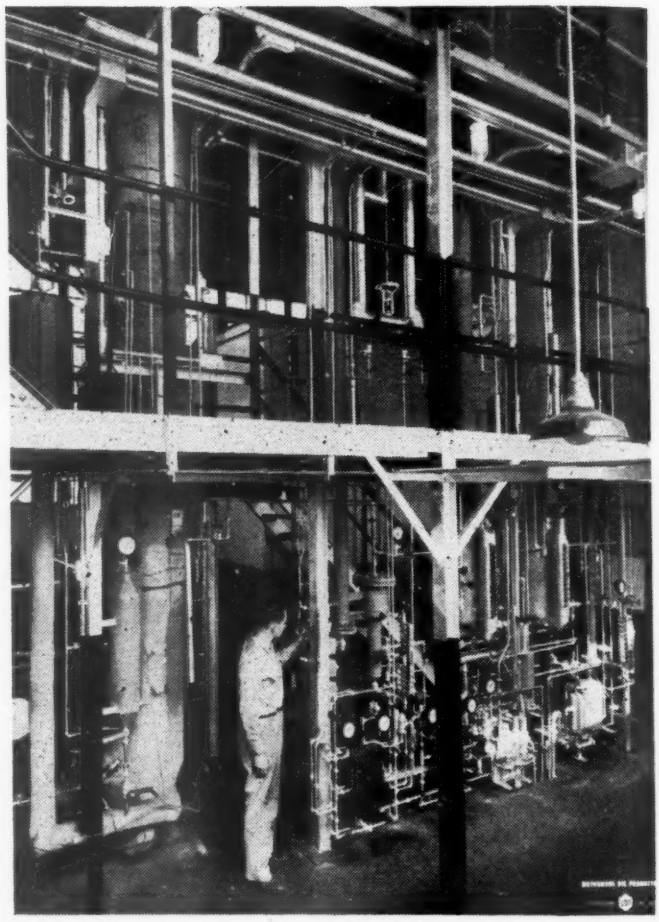
Experimental results indicate that a commercial unit embodying these improvements will produce considerably higher yields of gasoline than are obtained in catalytic cracking units of conventional design and will substantially reduce the amount of coke that must be burned. Any reduction in the quantity of coke effects important operating economies.

The higher yield of gasoline is mainly accomplished by two features, namely, better utilization of space in reactor and regenerator, and more efficient stripping of adsorbed light fractions from the spent catalyst. Better utilization of space is achieved by the installation of distribution grids of original design in the reactor and regenerator. This design feature minimizes over-cracking and particularly the cracking of catalytic gasoline fractions to gas and coke. The improved stripping is accomplished by the use of an external stripper that allows intimate and efficient contact between the stripping medium, which is steam, and the spent catalyst.

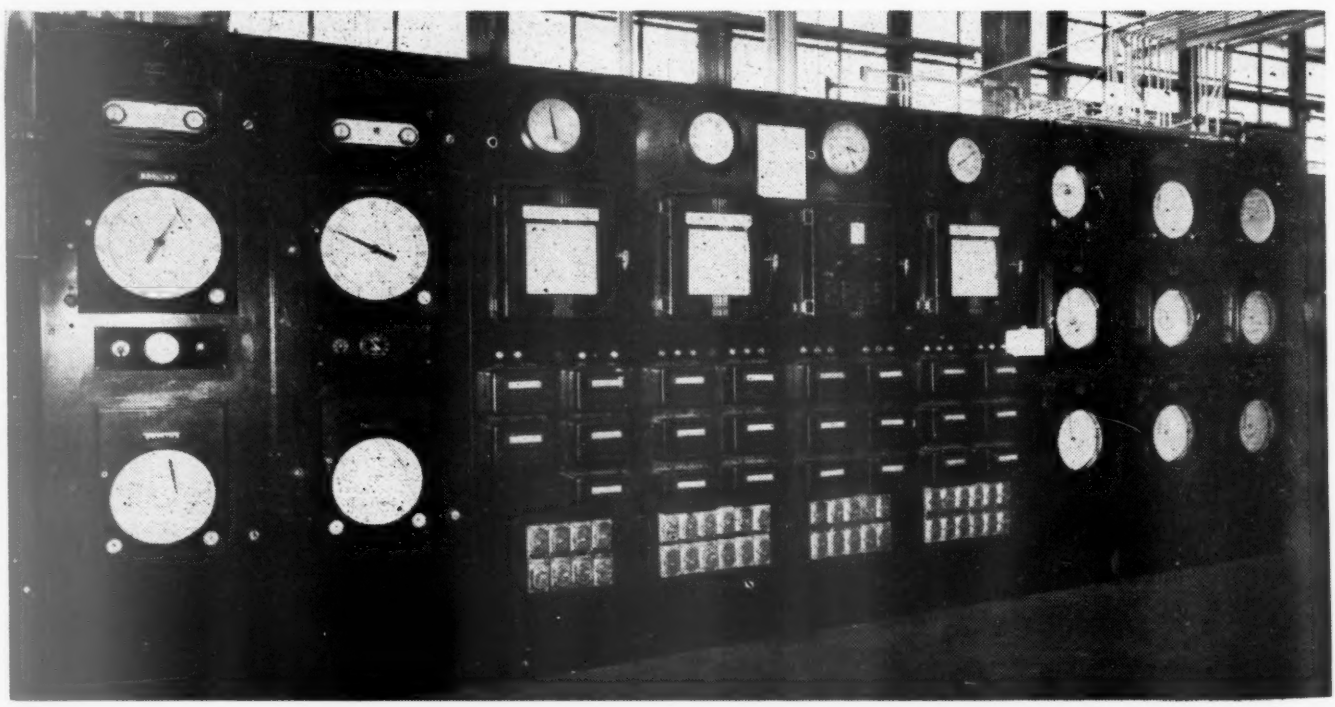
In the new U.O.P. design, coke formation is lessened by two major factors:

1. The more efficient stripping of the spent catalyst, which removes gasoline fractions that otherwise would be lost, also removes much of the heavy coke-forming hydrocarbons before the spent catalyst goes to the regenerator.

2. Countercurrent flow of spent catalyst and hot flue gas in the regenerator permits the use of the top zone of the regenerator dense phase catalyst bed as a "distillation" section. In this section, flue gas at temperatures higher than those prevailing in the stripper, and practically devoid of oxygen, meets the downcoming spent catalyst, serving to distill off much of the heavy hydrocarbons, thus further reducing the formation of coke.



Right—The latest U.O.P. fluid catalytic cracking pilot plant.
Below—Instrument panel of the pilot plant.



INCIDENTS FROM SMITHway PRESSURE VESSEL RESEARCH

PROJECT No. 33,117

Nonferrous weld ductility increased from 16% to 40%

IN metallic arc-welding of heavy plates of certain nonferrous metals—phosphor-bronze, for instance—metallurgists long since found that commercially available electrodes produced welds of uncertain quality.

Such welds tend to be high in porosity, low in ductility, and are subject to cracking.

These three shortcomings severely limited the use of arc welding for the fabrication of pressure vessels which were to be subjected in service to high temperatures and to high pressures.

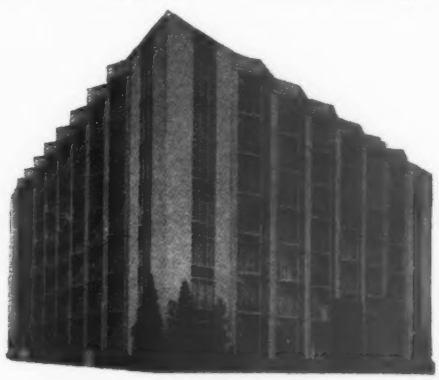
During the late war, however, the ability to weld nonferrous heavy plate satisfactorily became so vitally important that several of the A. O. Smith laboratories began a concentrated study on the subject.

Their answer was relatively simple and conclusive. By three carefully controlled techniques they eliminated porosity, overcame the tendency to crack, and they increased ductility from an average of 16% elongation in a two-inch gage-length to a new high of 40%, *without loss of tensile strength.*

The techniques employed included pre-treatment of the welding electrodes, followed by a closely controlled pre-heating procedure and welding sequence,

and concluding with a unique form of post-welding treatment of each welding pass.

The important fact, however, is that through immediately available integrated research, another pressure vessel fabrication problem was solved promptly, successfully, and practically.



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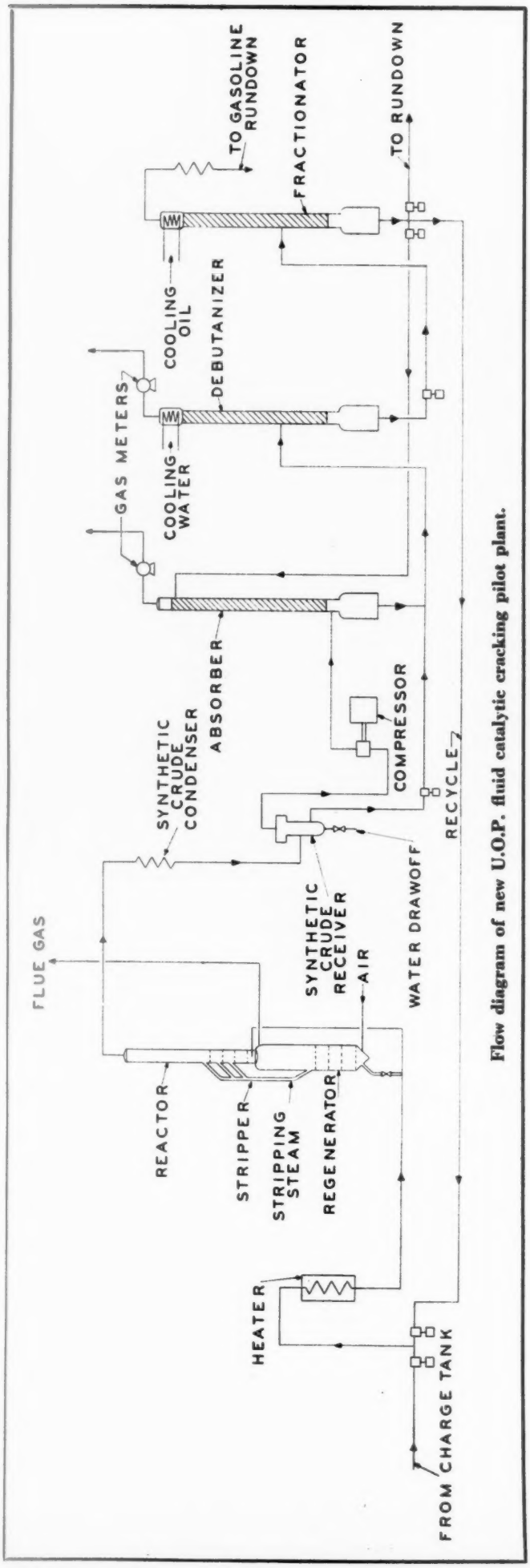


Flow diagram of new U.O.P. fluid catalytic cracking pilot plant.

Considerable economy in construction results from reduction in size of reactor and regenerator, which is made possible by more efficient space utilization.

In designing the latest U.O.P. pilot plant, engineers had at hand extensive data that had been obtained through long study of catalyst circulation in glass models and operation of previous fluid catalyst pilot plants, as well as the practical experience gained in the design and operation during the war of more than a dozen conventional type commercial fluid catalytic cracking units.

Certain of the features now embodied in the new pilot plant are illustrated in a small, glass working model in which the catalyst is circulated by compressed air. This model has been on display for months in the Universal offices and has attracted considerable interest when shown at several meetings of refiners' associations.

The new pilot plant normally runs 3-4 bbl. of fresh feed and recycle per day. Its principal parts are:

An electrically fired radiant tubular heater, really a miniature U.O.P. Equiflux heater.

A reactor-regenerator assembly approximately 23 ft. high and 10 in. ID, in which the reactor is at the top of the column and the regenerator is at the bottom.

A synthetic crude condenser, which cools and condenses the effluent from the reactor.

A synthetic crude receiver provided to separate uncondensed gases from the liquid.

A compressor that takes uncondensed gases from the receiver and passes them to a high pressure absorber for recovery of butane-butylene fractions that otherwise would be lost.

A debutanizer for removing the dissolved gas from both the synthetic crude and the rich absorption oil.

A fractionator that processes the debutanizer bottoms stream for separation of catalytic gasoline from unconverted gas oil. A portion of the gas oil is used as absorption oil in the absorber. The rest is recycled or removed as a net product.

Control instruments required for precise operation of the unit are mounted on an instrument panel that is necessarily at least as complete as that of a large commercial unit because of the variety of experimental data required.

This new plant has been operated on normal gas oils, and also on heavy gas oils with endpoints up to 1000 F., and has confirmed the increased gasoline yield and reduced coke expected by the design engineers. The same features that produced these results in the pilot plant are incorporated in Universal designs for projected commercial units.

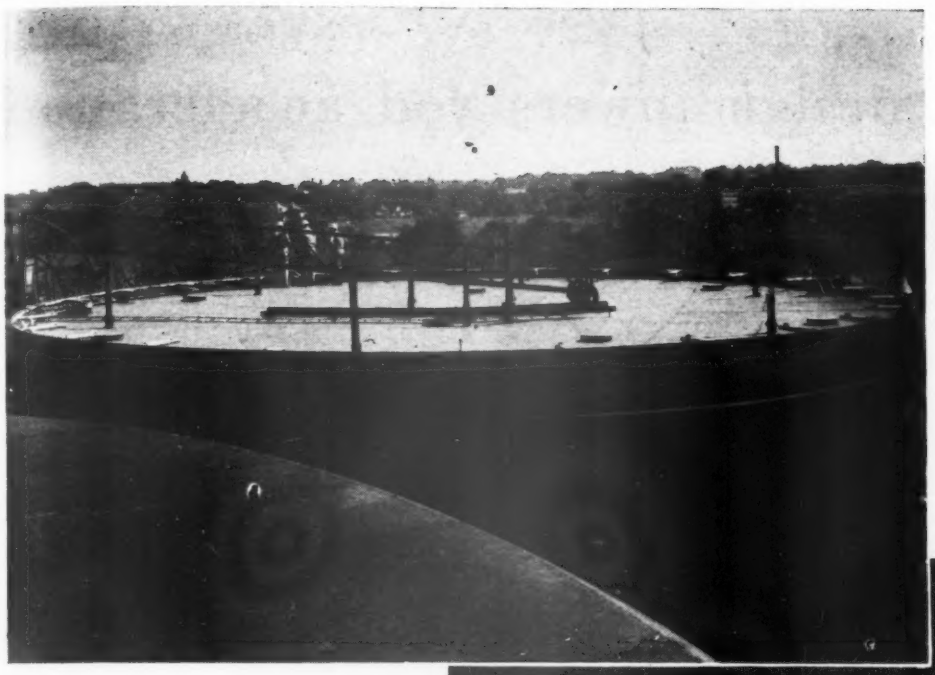
The accompanying diagram shows the flow through the pilot plant. ★★★

Technical data exchange plan

In a joint statement, W. A. Harriman, U. S. Secretary of Commerce, and Sir Stafford Cripps, president of Great Britian's Board of Trade, announced an Anglo-American agreement for the exchange of German technical information acquired by the two nations since VE-Day.

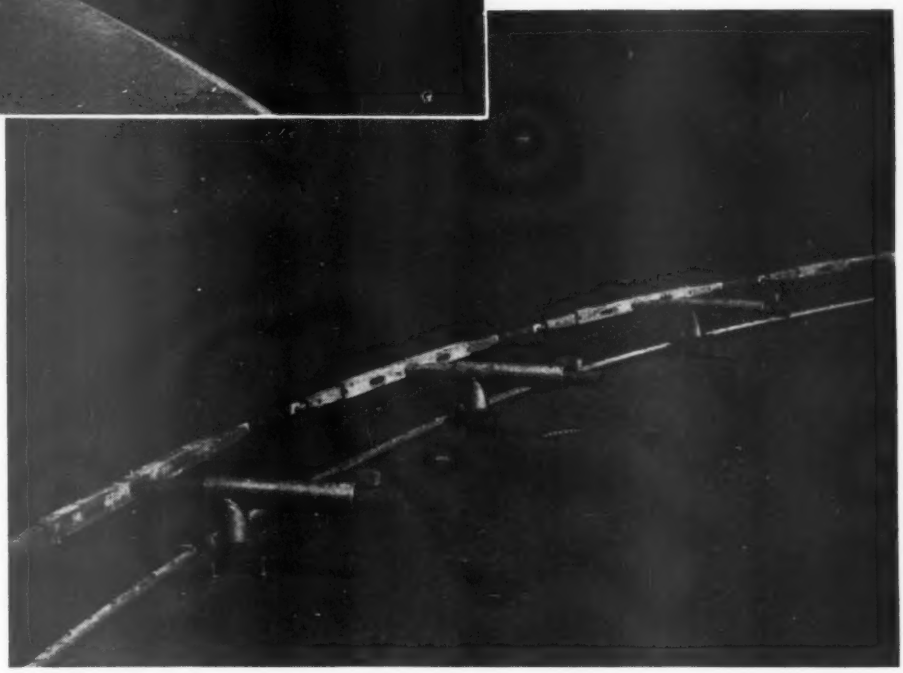
Hundreds of thousands of important German scientific and technical documents have been uncovered by British and American investigators in their respective zones, and microfilm copies have been made. Heretofore the exchange of these documents between the two nations has been imperfect; but under the present agreement representatives of each nation will be able to select from the other's storehouse of reports the items that they find valuable. Copies will be obtained on an exchange basis.

The American depository for German documents and microfilms is the Office of Technical Services, Department of Commerce. Three British experts are now examining the catalogs and abstracts of these reports, which have been prepared by OTS, and the Department of Commerce has agreed to provide microfilm copies of all items chosen by the screeners.



THE HORTON DOUBLE-DECK FLOATING ROOF

...protects volatile liquids from evaporation loss and fire



The Horton Double-Deck Floating Roof was developed by Chicago Bridge & Iron Company to help the petroleum industry reduce evaporation losses and cut down fire hazard during the storage of volatile liquids. It accomplishes these functions simply by covering the liquid with a double-deck roof and closing the space between the deck and tank shell with an effective seal. The roof floats directly on the liquid eliminating the vapor space in the tank. This prevents all filling evaporation losses and practically all standing storage evaporation losses. The elimination of the vapor space in the tank also removes most of the fire hazard.

The Horton Double-Deck Floating Roof is installed on new or existing tanks 15 ft. or more in diam. It is particularly recommended for tanks that are filled or emptied more than six times a year. It is also used on tanks in blending service and on tanks containing sour crudes. In this type of service, the Horton Floating Roof will pay for itself in a relatively short time by reducing product-loss through evaporation.

The photo at the top of the page shows a Horton Double-Deck Floating Roof on a 20,000-bbl. gasoline tank at the Nashville, Tenn. terminal of the Arkansas Fuel Oil Company. The view directly above shows the seal on a Horton Double-Deck Floating Roof on a 40,000-bbl. gasoline tank at the same location.

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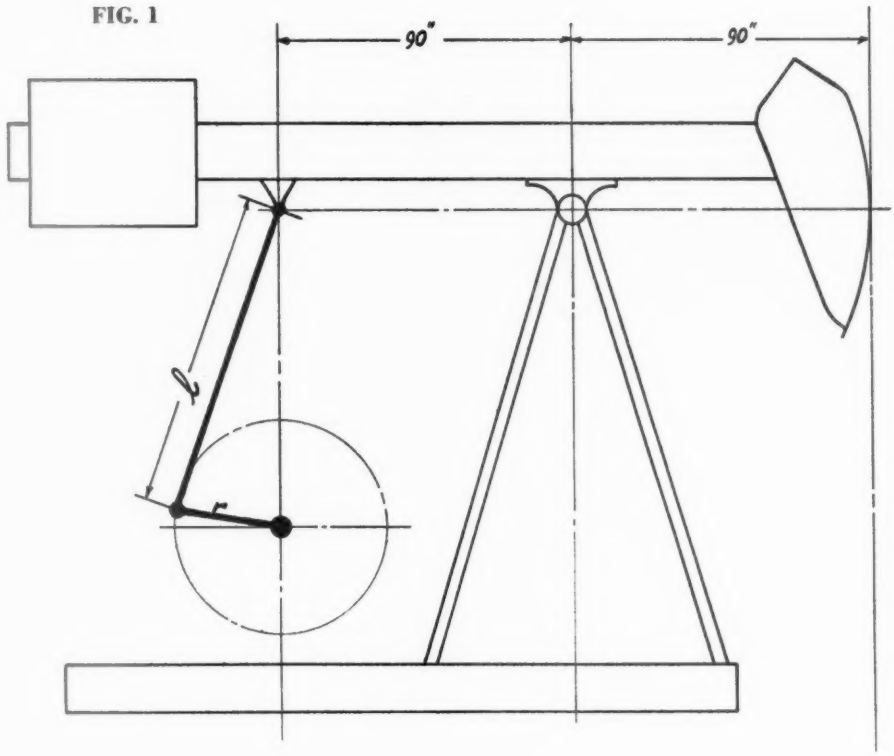
Pumping unit design lowers rod acceleration

By **J. B. WRIGLEY,** *Mechanical Engineer,* Lacy Oil Tool Company

FIG. 1



EXCLUSIVE

In the design of pumping units one of the objectives to be kept in mind is the proper proportioning of the moving parts such as the beam, crank, pitman, etc., to minimize the maximum acceleration of the sucker rod string and thereby improve rod life.

It is the purpose of this article to point out some interesting comparisons between the acceleration produced by a conventional unit and that produced by a unit with a lower ratio of crank to pitman length, and with the reducer placed on the same side of the samson post as the well.

It is obvious that the periods of maximum acceleration occur at the points of zero velocity, that is, at top and bottom dead center. Assuming a constant angular crank velocity it is easy to prove mathematically that when the crank is at the bottom of its stroke, as shown in Fig. 1, which illustrates a conventional pumping unit, and the polished rod is at the top of its stroke, the acceleration is substantially less than when the crank has moved through approximately 180 deg. and is at top dead center. This design causes the maximum acceleration of the upper part of the elastic string of

FIG. 2

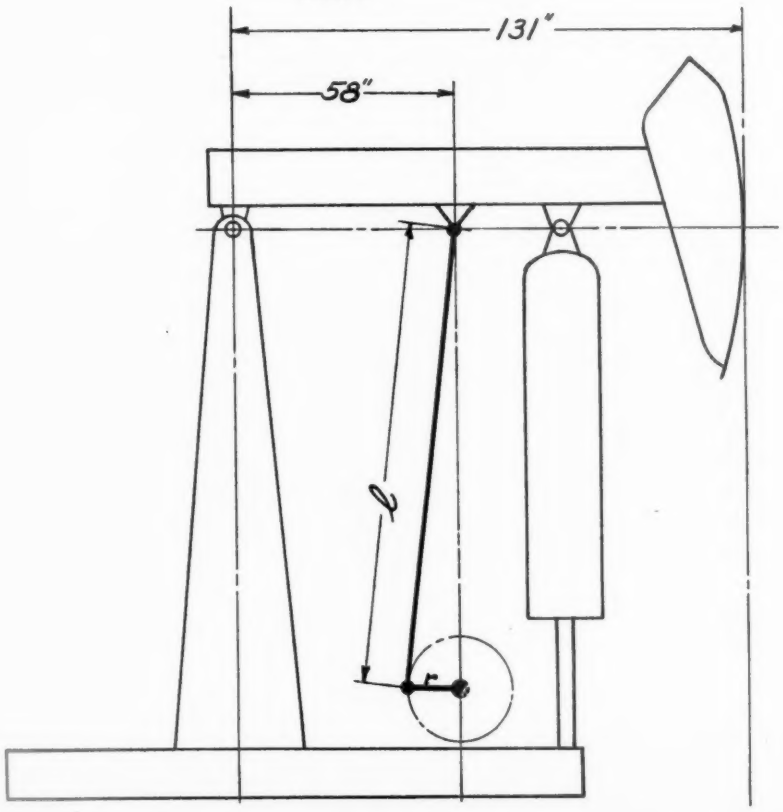
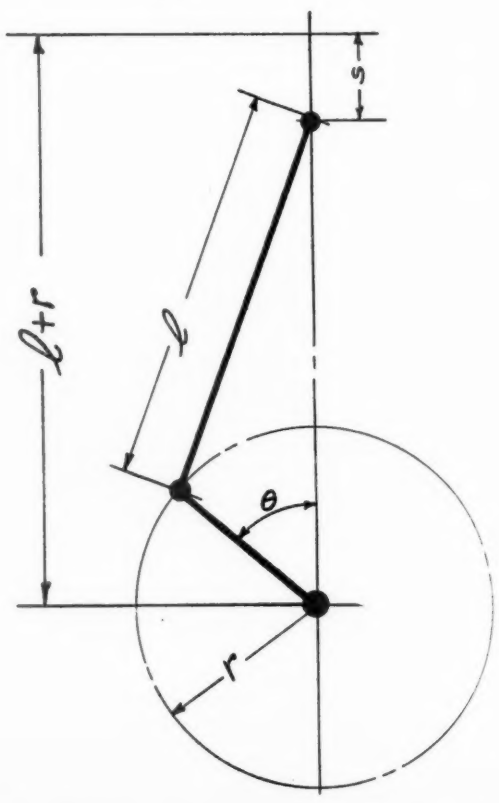


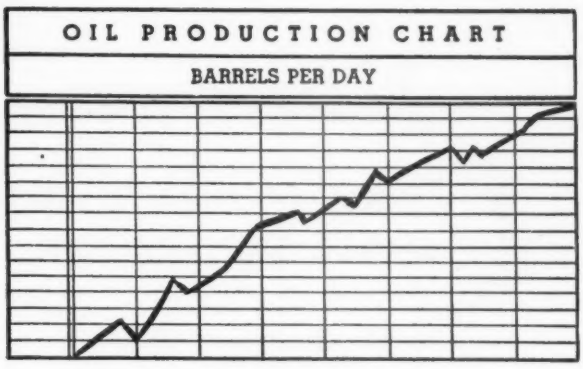
FIG. 3



Always on the "up-and-up"

So long as the rod goes up and down...

production profits go up-and-up.



The primary function of any sucker rod is to lift well-fluids to the surface with minimum down time due to rod failures.

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DEEP WELL PLUNGER PUMPS AND SUCKER RODS

rods to occur at the instant they begin to rise. The lower part, of course, does not receive maximum acceleration at this instant, because of elasticity of rods.

If, however, the reducer is placed on the same side of the samson post as the well, as shown in Fig. 2, it will be seen that now the period of lower acceleration of the polished rod occurs when the rods are beginning to be lifted, which is theoretically desirable. Another factor in this design that contributes to decreased maximum acceleration is the lower ratio of the crank radius to the length of the pitman rod. This, of course, increases the crank and pitman bearing loads.

● **Calculated difference in the maximum acceleration.** In order to show the magnitude of the difference in the maximum acceleration between the two designs, calculations for each will be given based on actual dimensions of typical manufactured units of the same capacity and with the same stroke.

In deriving the formula for acceleration it will be assumed that the upper pitman bearing moves in a straight line, as shown in Fig. 3, in order to simplify the mathematical calculations. This will give results that are conservative, as the curve slightly increases the acceleration:

Symbols

l = length of pitman rod, ft.,
r = crank radius, ft.,
s = space passed over by upper pitman bearing, ft.,
v = velocity of upper pitman bearing, ft. per sec.,
a = acceleration of upper pitman bearing, ft. per sec.,
w = angular velocity of wrist pin, radians per sec.,
θ = wt, the angle that crank makes with vertical center line,

$$c = \frac{r}{l}$$

From Fig. 3, it is obvious that the space passed over,

$$s = (l + r) - (l^2 - r^2 \sin^2 \theta)^{1/2} - r \cos \theta$$

$$v = \frac{ds}{dt} = w r \left[\sin \theta + \frac{r \sin 2\theta}{2(l^2 - r^2 \sin^2 \theta)^{1/2}} \right] \quad . \quad . \quad . \quad . \quad (1)$$

or, since $c = \frac{r}{l}$

$$v = w r \left[\sin \theta + \frac{c \sin 2\theta}{2(1 - c^2 \sin^2 \theta)^{1/2}} \right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$a = \frac{dv}{dt} = w^2 r \left[\cos \theta + \frac{c \cos 2\theta + c^3 \sin^4 \theta}{(1 - c^2 \sin^2 \theta)^{3/2}} \right] \quad . \quad . \quad . \quad (3)$$

Consider, first, the design shown in Fig. 1. The crank radius is 2.62 ft., the pitman is 7.9 ft. and $c = \frac{r}{l} = 0.331$. At 20 spm, $w = \frac{20}{60} \times 2\pi = 2.09$ radians per second. Substituting these values in equation (3), the acceleration of the upper pitman bearing and of the polished rod becomes at upper dead center, ($\theta = 0°$), $a = 15.3$ ft. per sec.^{2}, and at lower dead center, ($\theta = 180°$), $a = -7.7$ ft. per sec.^{2} This means that in the conventional unit the acceleration when the rods begin to rise is approximately twice as great as it is when they begin to fall.

Next, consider the design shown in Fig. 2. The crank radius is 1.17 ft., the pitman length is 9.9 ft., and $c = 0.118$. Substituting these values in equation (3), the acceleration of the upper pitman bearing becomes at upper dead center, ($\theta = 0°$), $a = 5.74$ ft. per sec.^{2}, and the acceleration at the polished rod becomes $a = 5.74 \times \frac{131}{58} = 13.0$ ft. per sec.^{2} At lower dead center, ($\theta = 180°$), the acceleration at the pitman bearing becomes $a = -4.52$ ft. per sec.^{2}, and at the polished rod, $a = -10.2$ ft. per sec.^{2} In this design, it will be noticed, the lower acceleration occurs as the rods begin to rise, which is desirable, as it produces a lower resultant force on the rod string.

When the acceleration at the start of the upstroke of the rods of the design in Fig. 1 is compared with that of Fig. 2, it is seen that the rate of Fig. 1 is approximately 50 per cent greater than that of Fig. 2. With this difference in theoretical acceleration it would be expected that the life of the rods would be favorably affected in wells pumped by the unit of Fig. 2. ★★★

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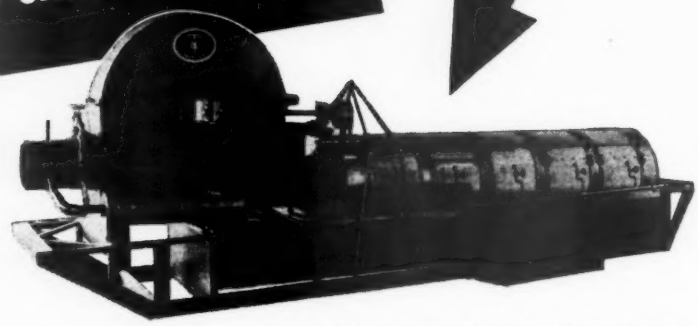

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6A-5

Liner job well remedial work in East Texas field*

By **D. W. AKINS,** *Division Petroleum Engineer*
The Ohio Oil Company

THE mechanism of the water drive of the East Texas field reservoir is understood generally by the operators in the field, and many have had experience in well remedial work of one kind or another. For years west side operators have been attempting to shut off or reduce salt water production by the dump bailer method, bradenhead squeeze, drillable-retainer squeeze, removable-retainer squeeze, use of plastics or some other method. Some of these jobs were satisfactory but many of them failed. No doubt a large number of the failures were due to a lack of knowledge of well conditions. The usual procedure when a well began making water was to obtain a sample of the water, titrate it, and if its chloride content was approximately that of Woodbine formation water, it was assumed to be coming from the bottom of the hole. If the electric log or core data indicated a shale break a few feet off bottom, the well was plugged back to that point and if the water was not shut off, it was said that the plug leaked. That assumption may have been true in some cases; however, the chances are that in many cases this conclusion was not true because there are too many instances now a matter of record where pipe line oil production has been obtained from zones of porosity below zones already flooded or partially flooded with salt water.

It has been known since shortly after development of the field began that the producing sands are lenticular and that the permeable and impermeable beds do not conform to the bedding plane of the Austin Chalk and other younger formations. Fig. 1 is a schematic sketch showing a generalized west-east cross-section of a part of the field. In the region of the East Texas field the Woodbine was thrust upward by the Sabine Uplift so that the beds dip toward the west. Then the upper part was peneplained off before the beds above were laid down, and the sketch shows how the reservoir is made up of many small traps as a result of the alternate sand and shale lenses being truncated. The beds are much more complex than here illustrated. Actually the sands are more or less continuous, but frequently the shales are not. As shown in the diagram, the thickness of the porous zones is not uniform. Permeabilities vary over a wide range, and it is not uncommon for one oil bearing zone to have an average permeability a hundred times greater than that of an adjoining zone. Some areas are drilled much more densely than others. Each of these factors has contributed to the uneven encroachment of salt water with the result that a single level water table does not exist. Instead there are many water levels and a well may penetrate several sand lenses already waterflooded and yet have undrilled zones below where salt water has not yet encroached. Fig. 1 shows such a well having relatively small portions of its bore exposed to oil bearing sands of two lenses. As a result this well would produce predominantly salt water. If the well were deepened through the next impermeable barrier it could be made to produce clean oil, provided the two upper zones were cased off.

The Ohio's first liner job was attempted on the C. L. Graham a/c 2 lease near the northwest corner of the Cadena survey. Water first appeared on this lease in December, 1943. During the next 13 months eight wells were plugged back to the top of the sand in the conventional manner by displacing cement down the tubing and drilling out with a small company workover rig. In four of these wells water was successfully shut off; it was reduced in another, but in the three remaining wells the water percentage was actually higher after workover than before. Oil production was increased in only one of the eight wells as a result of the plugbacks. All wells had been completed by setting casing in the base of the Austin Chalk and drilling or coring to total depth, usually 3270 to 3290 ft. subsea. In no case was a well completed in this manner below minus 3290 ft., as it was felt desirable to stay a safe distance above the water level, originally considered

*Presented before East Texas Chapter American Petroleum Institute, Kilgore, Texas, December 17, 1946.

FIG. 1

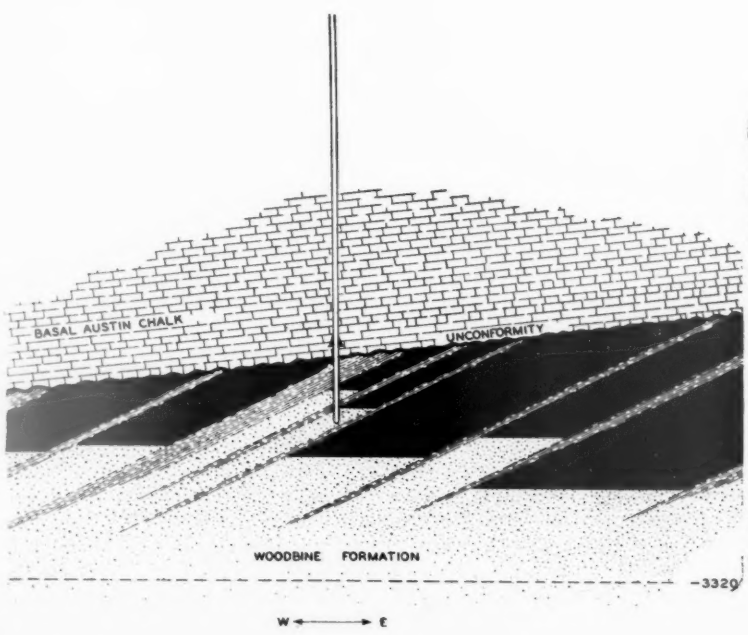
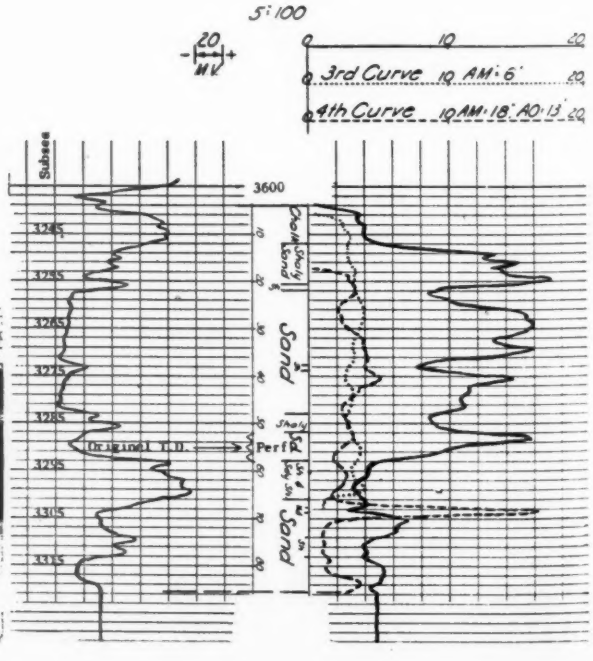
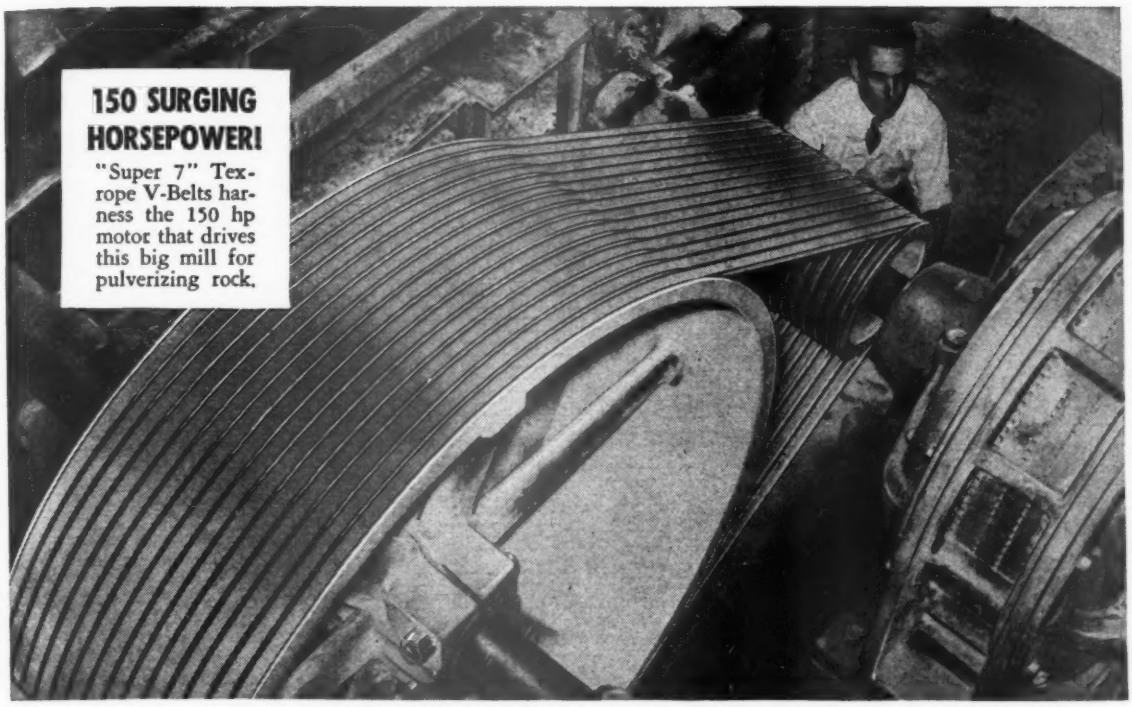


FIG. 2





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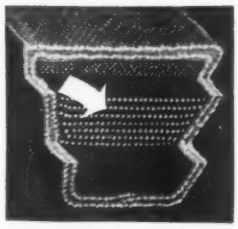

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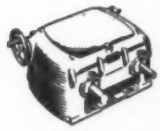

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FIG. 3

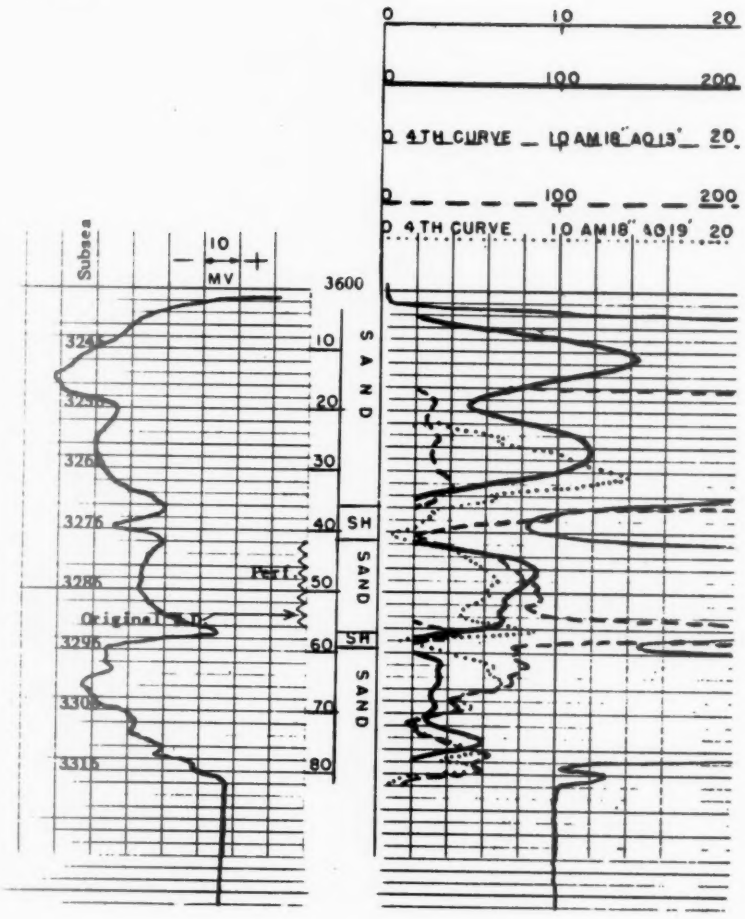
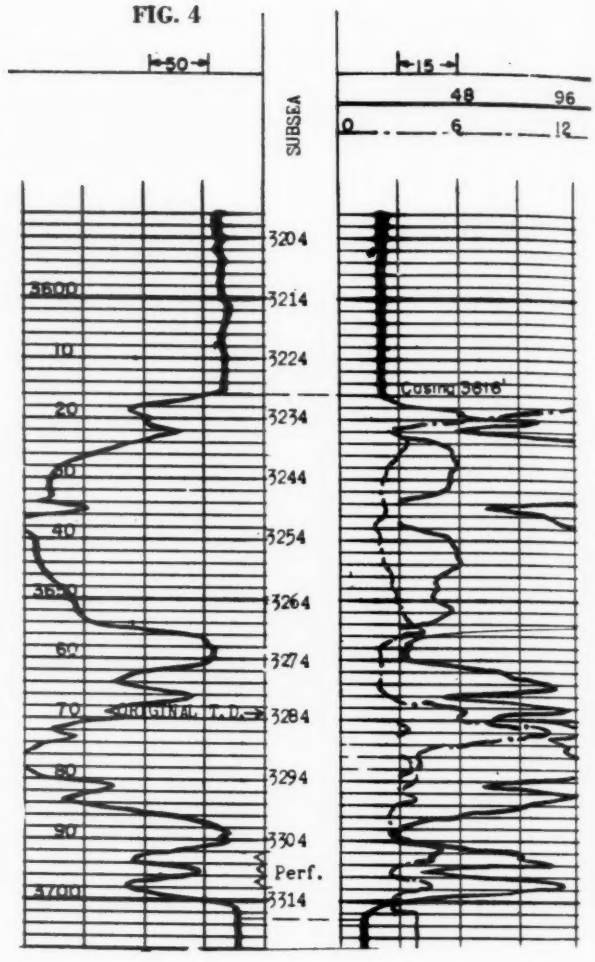


FIG. 4



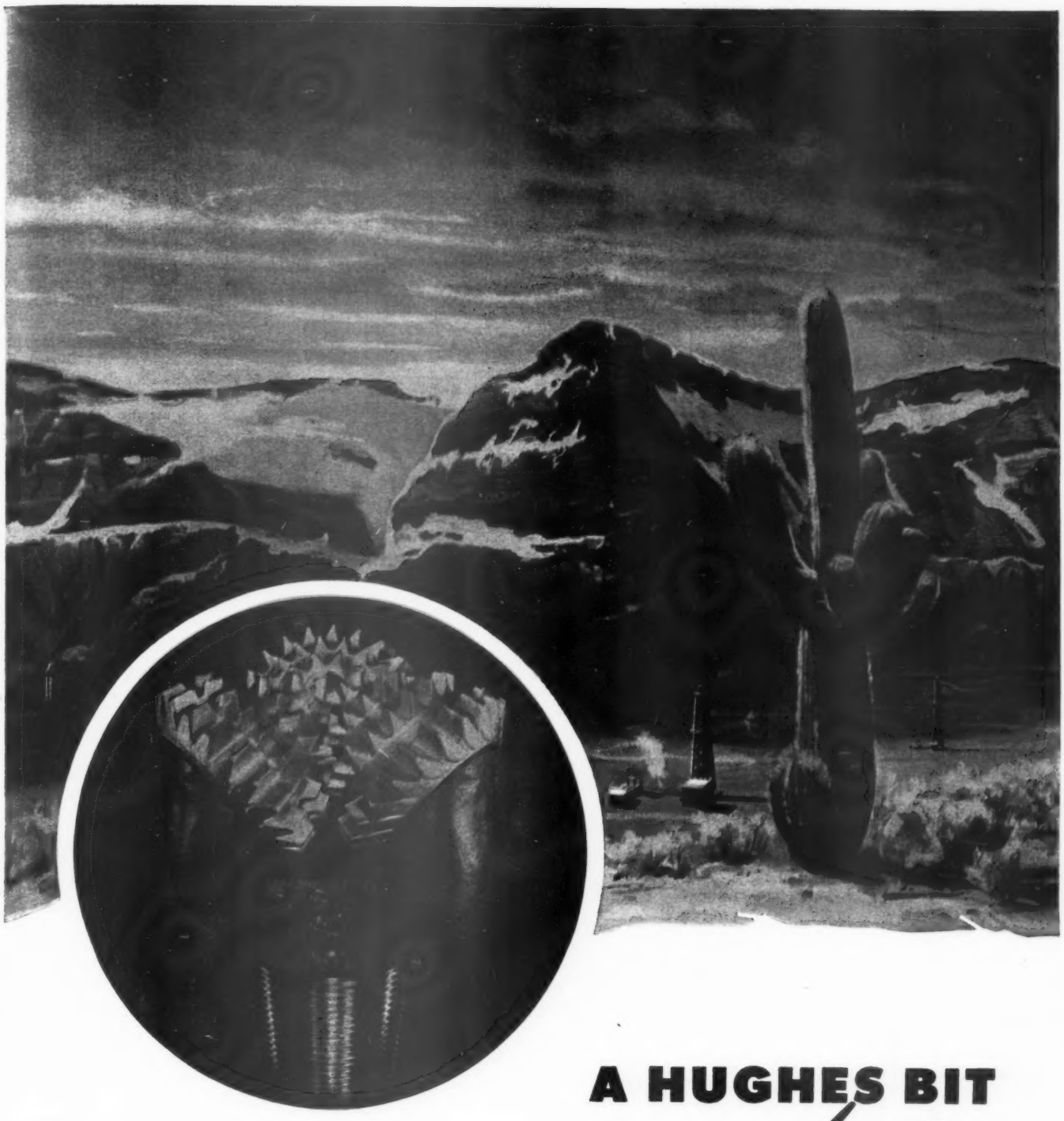
to be at minus 3320 ft. An offset to one of the wells worked over, however, had been drilled to minus 3329 ft., and casing set through and perforated from minus 3298 ft. to minus 3313 ft. This well was still producing pipe line oil through perforations more than 50 ft. below the bottom of wells that were producing copious quantities of salt water in the immediate vicinity.

It was natural to conclude that other wells could be made to produce clean oil if completed in this same zone. A well producing 96 per cent salt water was selected for the experiment. This well had been completed originally with 7-in. casing set in the base of the Chalk and drilled to a total depth of minus 3290 ft. Company workover tools were rigged up and the well deepened 30 ft. using a 6¼-in. rock bit on the 2½.in. EUE tubing pulled from the well. Clear water was used for circulating fluid, and cuttings were brought out using reverse circulation. Electric log was run and an attempt made to correlate cuttings with the survey. Fig. 2 shows the electric log of the well. The normal resistance curve shows high values of resistivity opposite the sands in the old hole. As the well was producing a high percentage of salt water it was concluded that these high readings were due to invasion of the fresh water used as drilling fluid. The lateral curve shows low readings in all zones except for a hard streak at minus 3303 ft. The third curve, or long normal, using a 6-ft. spacing, is almost flat in all zones except at minus 3287 ft. to minus 3293 ft. It will be noted that the electrode spacing is exactly the same as the thickness of this bed. In such cases the resistivity of the beds above and below have a great influence on the readings of a curve of this type, so that resistance values are recorded much lower than they actually are. Of course the low readings could also indicate the presence of salt water. The electric log did not hold much promise for the well. The cuttings, however, for the first 3 ft. drilled were well saturated with oil. The next 11 ft. were rather tight being mostly sandy shale, and below this depth the cuttings appeared to agree with the electric log in that all the sand was water bearing. A 5-in. OD blank liner was set on bottom giving 55 ft. overlap with the 7-in. casing. Fourteen sacks of cement were displaced down the tubing and out through a liner shoe equipped with a back pressure valve. After 72 hr. the liner was gun perforated with 10 shots opposite the zone minus 3287 ft. to minus 3292 ft. Tubing and rods were run and after pumping off the fresh water, the well made 32 bbl. of oil with no salt water in a seven hour test. Production gradually increased to more than 60 bbl. of clean oil in a seven hour test. As a result of the workover the allowable of the well was increased from 6.90 bbl. to 20 bbl. Total cost of the job was $1166.42. The increased production changed the classification of the well from marginal to proratable and therefore subject to shut down days. With an average of 21 producing days per month and 40 cents per bbl. lifting cost, the job paid out, after deducting royalty and direct taxes, in 5.36 months. This was considered a fair return on the expenditure. The same procedure was attempted on a second well on this lease with similar success. As the allowable was 20 bbl. prior to workover this well did not receive a higher allowable but water production was reduced from 80 per cent to zero. Eleven liner jobs have been completed on this lease to date. Water production was shut off entirely and oil production increased in seven of the eleven wells. Water production was reduced in the other four.

* * * * * *

For $22 a month, the up-to-the-minute Manhattan motorist soon may have a two-way radiotelephone in his car from which calls can be made from all sections of metropolitan New York to any phone on Bell telephone system.

After completion of the first few liner jobs the following procedure was set up. Rods and tubing are pulled. When these wells were drilled they were equipped with a liner that was shop perforated for that portion that would be in open hole. In nearly all instances we have been able to pull this liner with a releas-



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ing type spear run in on tubing. In some cases, however, it is necessary to use cable tools in order to get it out. After pulling the liner the well is drilled about 40 ft. deeper, using the tubing from the well with fresh water and reverse circulation. The kelly is marked off in 2-ft. lengths, and, after drilling each 2-ft. section of hole, circulation is continued from three to five minutes before beginning to drill the next 2-ft. section. In this way cuttings from each 2 ft. of hole drilled are separated from those of the next 2-ft. section by a column of clear water. A record is kept of each section drilled. Electric log is then run and correlated with cuttings from the well. Usually four joints (approximately 120 ft.) of 5-in. OD 15-lb. casing, with liner shoe, is run in the hole on a jay tool and set on bottom. Tubing is pulled and the jay tool replaced with a cup assembly and run back in the hole. The cups are seated in the shoe and circulation established behind the liner. Fifty sacks of slow set cement are pumped down the tubing, followed by 16 bbl. of water. This leaves about 5 bbl. of cement in the tubing. Tubing is then raised, allowing the cement to equalize and fill the liner and extend on up into the casing. Three thribbles (about 270 ft.) are stood back in the derrick. The bradenhead is then packed off around the tubing and a squeeze is obtained by raising the pressure from 1000 to 1400 lb. In no case are more than 2 bbl. of cement displaced during the squeeze as it is desirable to leave cement between the liner and the 7-in. casing. The pressure is released after about 5 min. and the cement inside the liner washed out with reverse circulation as tubing is lowered to within 4 or 5 ft. of the shoe. After 72 hr. WOC the liner is perforated opposite the zone indicated by cuttings and electric log to hold the most promise.

Fig. 3 is the electric log of a well originally bottomed at minus 3290 ft. The normal curve of this log shows the effect of fresh water invasion, as do all these logs. The two lateral curves indicate fairly high values opposite the sand zones above minus 3292 ft. Liner was set and gun perforated with 20 shots from minus 3278 ft. to minus 3292 ft. Before workover the well produced 70 per cent salt water. After workover it produced clean oil with the allowable remaining at 20 bbl. If this well had been plugged back in the conventional manner to the top of the sand it seems apparent that salt water production would not have been eliminated. Fig. 4 is the electric log of a well whose original total depth was minus 3283 ft., and was producing 95 per cent salt water before workover. The liner was perforated from minus 3306 ft. to minus 3312 ft. with 24 shots. As a result of the workover the allowable was increased from 5.52 bbl. per day to 20 bbl. per day. Water production was not shut off but it was reduced to 71 per cent.

Fig. 5 shows the electric log of a well that produced 89 per cent salt water when bottomed at minus 3285 ft. After being recompleted by perforating the liner from minus 3293 ft. to minus 3297 ft. with 13 shots, water production was reduced to zero. Oil production remained at 20 bbl. per day.

Fig. 6 is the electric log of a well which was producing 98 per cent salt water when bottomed at minus 3290 ft. After the liner was perforated from minus 3299 ft. to minus 3303 ft. it produced 100 per cent salt water. This zone was squeezed and the liner perforated

Philippine project

Colonel Andres Soriano, president of Far East Oil Development Company, Inc., of the Philippines, announced the completion of a contract with Kern Drilling Corporation of Long Beach, California, for oil well drilling in the Philippines. The company is resuming the testing of a promising structure on the Island of Cebu, which was interrupted by the Japanese invasion. It is also planned to test other areas in the Philippines.

The contractor has assembled complete heavy-duty rotary equipment, which is being shipped from the United States. Colonel Soriano, Grant Corby, geologist, and Alfred E. Ireland, superintendent, assisted in the negotiation of the agreement.

FIG. 5

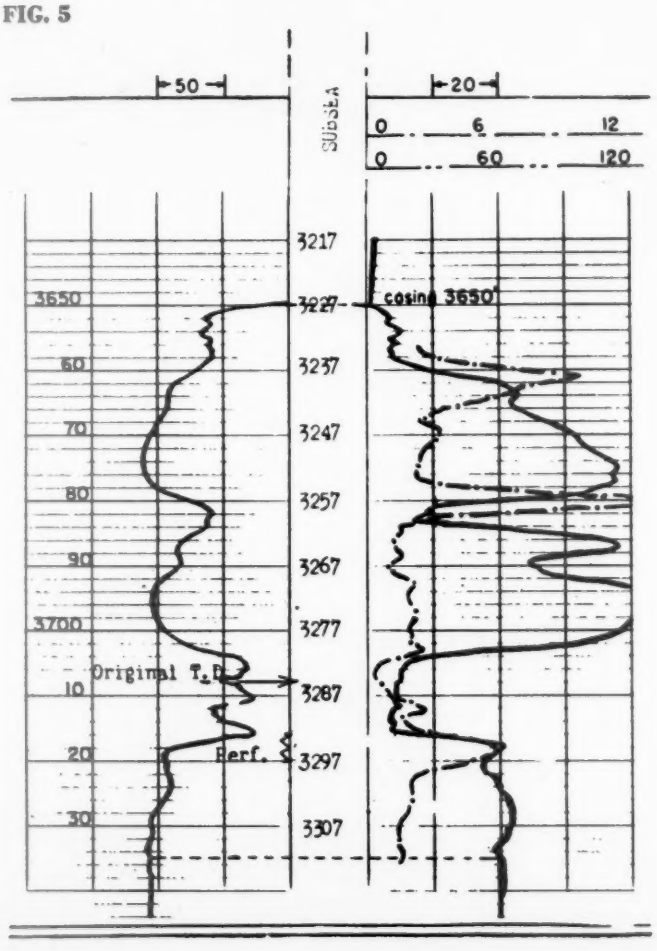
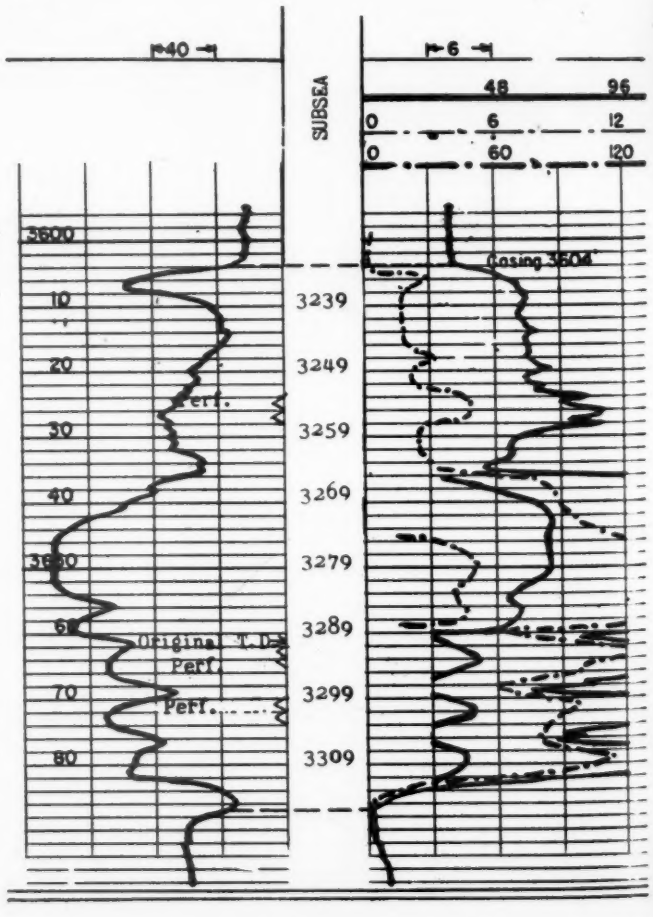


FIG. 6



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. . . says Wiegand Bros. Drilling Company

At the close of 1945, Wiegand Brothers Drilling Company were operating eight BUDA Diesel Drilling Engines, which had drilled more than 50,000 feet on seven jobs. Here's what they say about these units: "The performance of these engines has been outstanding and the very excellent field service rendered by your engineering staff has kept our rigs in good running order.

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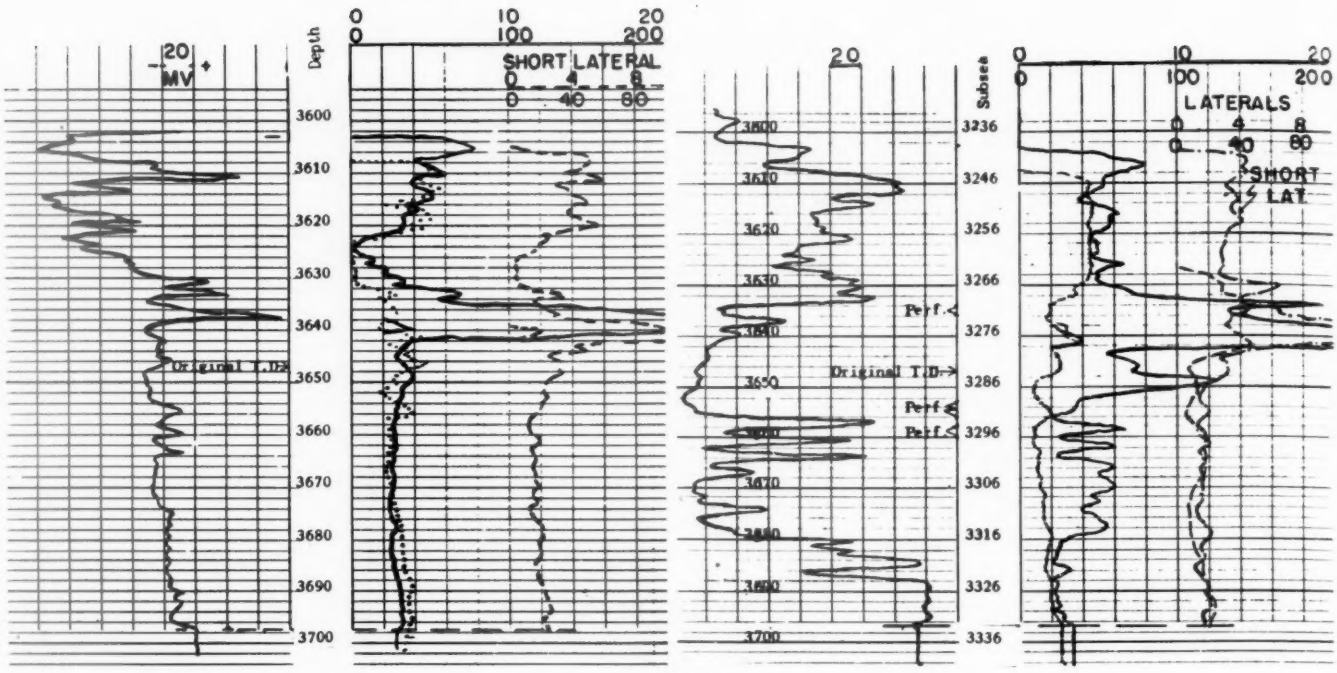


FIG. 7

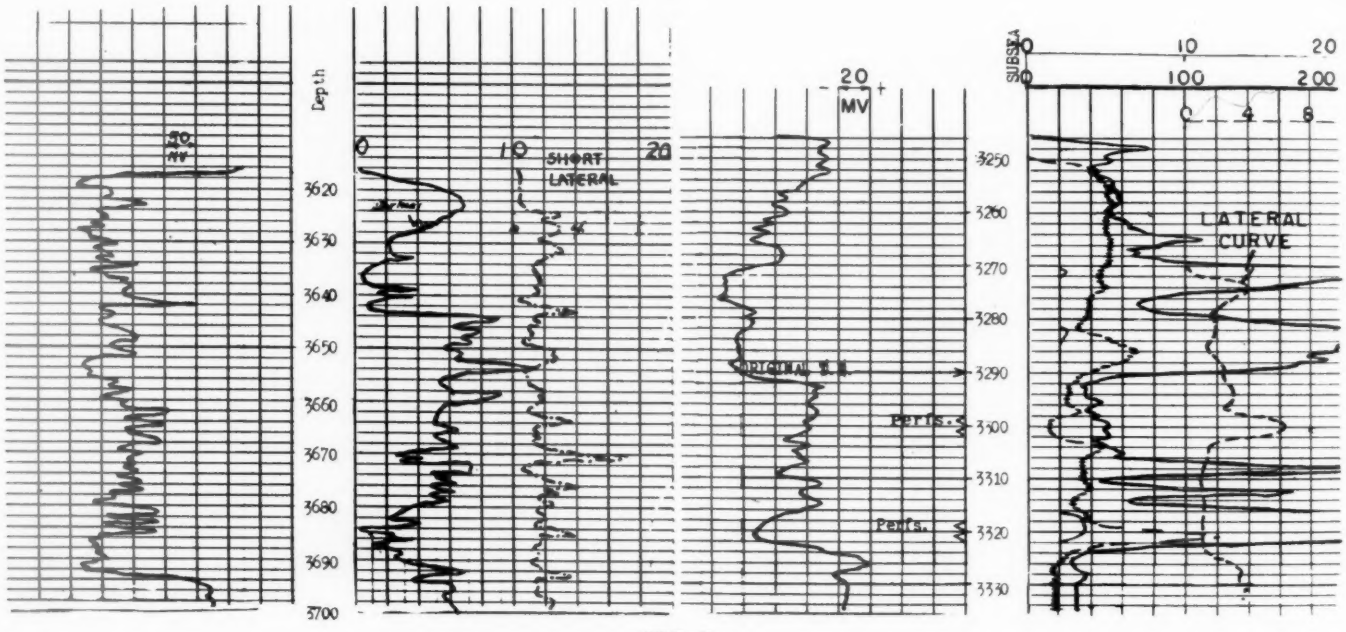
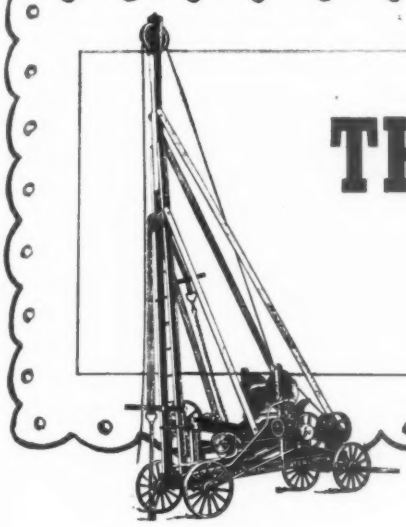


FIG. 8

from minus 3291 ft. to minus 3294 ft. and the well produced 100 per cent salt water from this zone also. These perforations were squeezed off, the tight zone from minus 3253 ft. to minus 3257 ft. was perforated and the well again tested 100 per cent salt water. When the well was deepened most of the cuttings were badly broken up and lost; it was felt that the sands were too porous and soft for recovery. The electric log indicated fairly high resistance readings for both curves at the zones tested.

The electric log companies have been very cooperative in trying to supply surveys that could be more positively interpreted. They have helped us by experimenting with various electrode spacings, by running check surveys against each other, and by taking sidewall cores, all at no cost to us. In two wells electric logs were provided with the wells surveyed in oil and followed by the regular surveys in fresh water. The purpose of this was to try to obtain a log that would give better information as to the fluid content of the sands. From past experience it was known that fresh water would displace the salt water so that high resistance readings would be obtained. It was felt that hole conditions would be disturbed less if the well were drilled deeper using oil instead of water. Fig. 7 shows on the left the survey run in oil and on the right the one run in fresh water. The hole was deepened with oil. surveyed, and then the oil displaced with water and the hole resurveyed. The oil survey proved to be of no value in making better interpretation than the survey made in water. Two zones were perforated and tested separately below the original total depth, which was minus 3283 ft.; both tested 100 per cent salt water. After squeezing, the well was again perforated from minus 3270 ft. to minus 3272 ft. Before workover the well was making 96 per cent salt water with an allowable of 5.52 bbl. per day. After workover the well tested approximately the same percentage of water with no change in oil allowable.

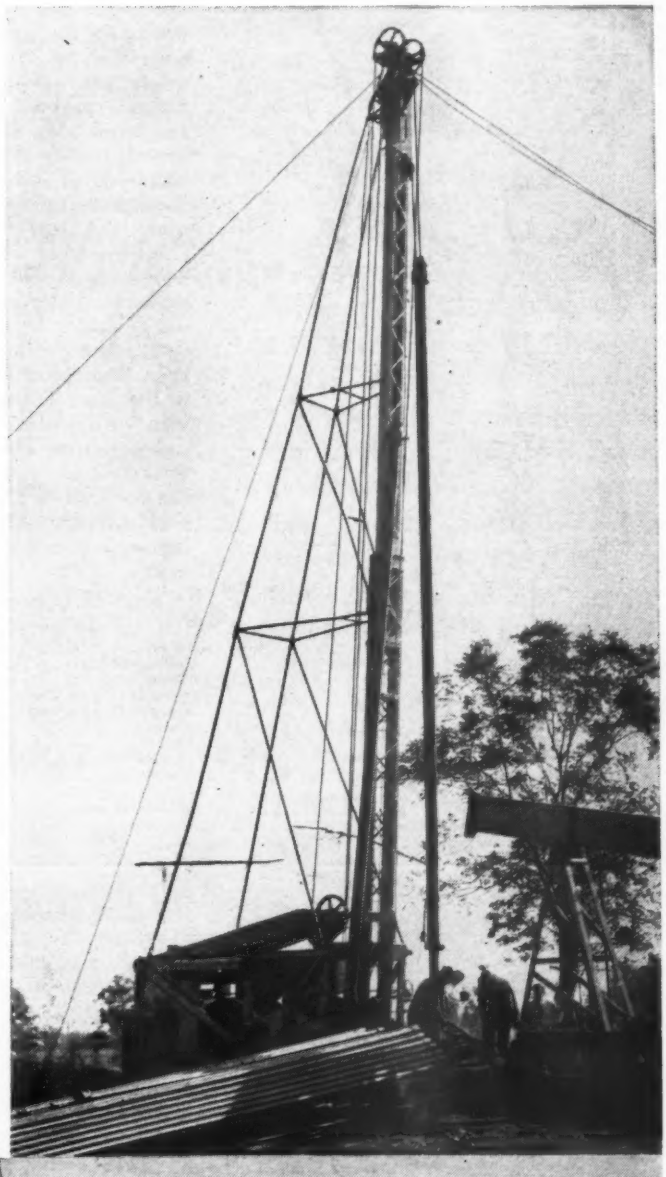
Fig. 8 shows another comparison between logs of a well surveyed in oil and in fresh water. The well was deepened with oil and the survey on the left obtained. After displacing the oil with fresh water the survey on the right was obtained. The original total depth was minus 3290 ft. Liner was set in the usual manner and perforated from minus 3318 ft. to minus 3322 ft. with 16 shots. The well produced a high percentage of salt



THERE'VE BEEN SOME CHANGES MADE!

Only a few years ago, spudders were limited to extremely shallow depths, were equipped to handle only a few minor operations, were "portable" only if you stretched the term, did not have the structural strength to handle oil-field work effectively.

Today, in contrast, it is not unusual to see a Bucyrus-Erie 36-L spudder working in excess of 5000 feet. It is big, powerful, yet trim and compact. It handles efficiently a wide range of operations — top-to-bottom drilling, tailing-in, swabbing, clean-out, tubing-and-rod servicing. It swings up to 7000 pounds of tools and cable, has a derrick which handles 50,000 pounds static load (with casing tackle strut, 60,000 pounds; with auxiliary A-frame leg, 90,000 pounds.) It has hoisting speeds that permit fast handling of tools, bailer, casing, etc. With two forward speeds and instantaneous reverse on all drums, it has the split-second control needed for diversified work. It is easy to rig up, easy to operate, easy to move over the road. Its all steel welded construction and easy accessibility mean durability and maintenance handling ease. Its ability to deliver effective low-cost performance has been proved in the field.



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water from this zone so the perforations were squeezed and the liner perforated from minus 3298 ft. to minus 3302 ft. with 10 shots. Before workover the well made 99 per cent salt water and had an allowable of 2.76 bbl. per day. After recompletion the well produced 100 per cent clean oil and its allowable was increased to 20 bbl. per day.

Before attempting any kind of well remedial work the economics must be carefully considered. A detailed cost estimate of the job should be prepared and some kind of an estimate made of the amount of increased oil production that will probably result from the workover. If the cost is too high or the additional oil to be recovered is too small the job cannot pay out. There is no sure way, at least we know of none, to estimate accurately the amount of additional oil that the workover will yield. As shown by some of the foregoing examples the well may not be improved at all. When a liner job is being considered on a lease that has its water production history established, future oil production can be estimated from the production decline curve of those wells already gone to water. In the absence of such information the decline curve set up by the Texas Railroad Commission may be resorted to for making estimates. This curve is necessarily an average and it goes without saying that the well undergoing repairs may prove to be better or worse than the curve indicates. The operator doing work of this kind must consider the overall picture and average his successes with his failures in order to determine the economic soundness of his program. So far as decreasing water production is concerned, it is assumed for this purpose that the net value of bonus oil allowable for water injected exactly equals the cost of disposal. The reduction of salt water production will result in certain benefits such as reduced wear and tear on lifting equipment, elimination of corrosion, reduction in treating cost, etc. These are difficult to evaluate, however, and most managements prefer to justify the expenditure on the basis of increased oil production only. Because of low per well allowables in the East Texas field, the rate of return on the expenditure is fixed within rather narrow limits. Let us consider a liner job, on a well whose production has declined to 8 bbl. per day. A typical cost estimate, based on Ohio's experience, is shown in the following tabulation:

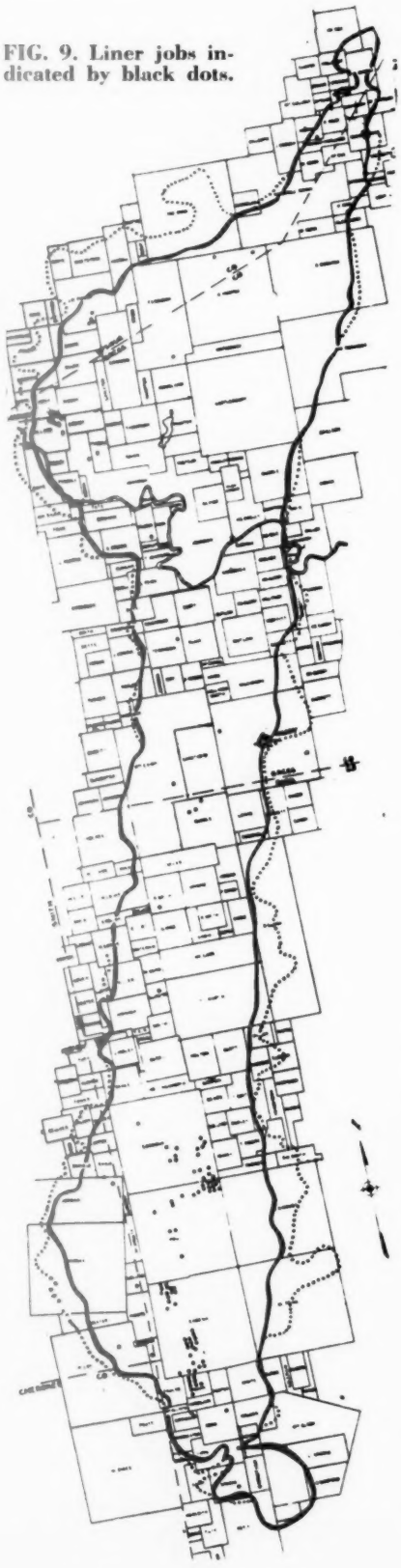

FIG. 9. Liner jobs indicated by black dots.

	Number	Units	Cost
Labor	24	Man days	$ 260
Pulling unit	48	Hours	120
Cleanout tools	48	Hours	120
Trucking (1½ ton truck)	18	Hours	27
Trucking (2½ ton truck)	3	Hours	8
Liner	120	Feet	60
Cement	50	Sacks	48
Set shoe	1		35
Electric log	1		200
Cementing service	1		231
Perforating cost	2	Jobs	332
Total			$1441

If, after successful workover, the well is capable of producing 20 or more bbl. of oil per day, its allowable in a 21-day producing month is 21/30 of 20, or 14 bbl. per day. As the well already had 8 bbl. allowable the operation must pay for itself from the 6 bbl. additional allowable less royalty and direct taxes. Using these factors it can be shown that the expenditure will be returned in 7¼ months.

$$\$1441 = 6\ (.875)\ (\$1.70)\ X - 6\ (\$.40 + \$.07)\ X$$
$$X = 232 \text{ days or } 7.25 \text{ months}$$

A year after the world's largest oil field, East Texas, was discovered in 1930, it was estimated that total recovery would be about two billion barrels. It has produced well over two billion barrels already, and remaining reserves are estimated at about three billion.

★ ★ ★ ★ ★ ★

Assuming that the well showed on test after workover to be capable of producing 30 bbl. of oil per day it will have, according to the Railroad Commission's curve, approximately 28 months of production before reaching the abandonment stage of 4 bbl. per day. As it will require only 7¼ months to return the expenditure the operation will have nearly 21 months additional production from which to show a profit. The job will be both an operational and economic success.

Let us assume that the job cost $6000. Using the same factors as in the example above it will require more than 32 months for the expenditure to be returned.

$$\$6000 = 6\ (.875)\ (\$1.70)\ X - 6\ (\$.40 + \$.07)\ X$$
$$X = 916 \text{ days or } 32.2 \text{ months}$$

As the Railroad Commission's curve shows a 30 bbl. well to have only 28 months productive life before abandonment, the job cannot pay out. In this case the workover would be an operational success but an economic failure. Some of the more expensive workovers will pay out when considered alone, but by the time a few failures are averaged in it is apparent that costly jobs must be avoided.

Fig. 9 is a map of the field showing the location of all liner jobs completed up to November 1, 1946. Major and independent operators have been interested in this type of remedial work for about two years. Considerable progress has been made but the present technique of recompleting wells in oil saturated zones below zones already flooded with salt water is far from satisfactory. It is impossible to correlate electric logs sufficiently to extrapolate into unworked areas even a short distance away. The sections are too broken and too short, as shown by the foregoing electric log examples. It would be of great value in this type of work if the electric log positively interpreted as to fluid content in these broken zones. As the field gets older and salt water encroaches farther to the east the formations become more broken. Greater differences in water levels will exist and the operator will find the liner method a valuable approach to the problem of extending the life of his wells.

Grateful acknowledgment is made The Ohio Oil Company for permission to prepare this report and appreciation is expressed to the employes in the Shreveport division and the East Texas district for their valuable assistance, and to Halliburton and Schlumberger for their helpful cooperation. ★ ★ ★

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Tomorrow's Tools–Today!

A new approach to mechanical orifice meter chart computation

By **W. F. MARTIN,** Texoma Natural Gas Company

EXCLUSIVE

During 15 years of observation, the writer has noted that the great majority of orifice meter charts with which he came in contact, have had a comparably regular static pressure. This means that most charts would come within the scope of a square root planimeter. The square root planimeter will make an accurate computation if *one* of the two lines on the chart does not vary to an appreciable extent.

The writer has visualized a device that he will call an electric square root planimeter. It is also a device that will permit the introduction of a factor into the computation. This means that the static can be used as a percentage factor, and if so used, a run of the differential will result in the "pressure extension." This will obviate one step in arriving at the volume of gas.

The method of using a counter wheel has also been changed. This is to permit greater bearing space for the counter wheel. The zero position of this wheel is to be five of its diameters from the center of the chart, and it moves in as tracing stylus (non-recording) moves out. This means that the counter wheel will revolve backward, and that the end of chart run must be at point of beginning with reference to radial line. If the chart does not run a full period, the stylus is moved to zero and the circle is completed. If the chart runs for more than a full period, the stylus is moved to zero at the end of the run and then is moved back to the point of beginning. This operation assumes a 100 per cent factor in the counter assembly.

It will be noted from the sketch that the counter wheel assembly is set within a circular steel ring within a circular steel ring. The first quarter of the outer steel ring is graduated from 0 to 100. The inner steel ring is equipped with a vernier. This will permit the introduction of a three place factor; for instance, a static of 0.721. This factor is introduced by setting the counter wheel at an angle to its line of travel. The operation, when a factor of less than 100 per cent is used, will be as follows. (It is illustrated with a chart.)

It will be noted that the chart is on at 8:00 p.m. on June 10, 1946; it is off at 3:00 p.m. on June 11, 1946. It fails to be a full period, and the full period must be run. The machine pointer or stylus is placed at 8:00 p.m. on chart zero and it is run backward to 3:00 p.m., where stylus is moved out to 0.734. The differential line is then followed with the stylus to 8:00 p.m. (time on), at which point the stylus is moved to chart zero. The reading is taken from the counter at this point. The reading for the chart is arrived at as follows: The negative of the factor used is added to the initial counter reading and the sum is subtracted from the final counter reading. An example follows:

Example:

Given: The chart has a static of 0.7210 (reading from a square root chart.) The initial counter reading is 0.5000. The final reading of counter is 0.0674.

Required: Chart extension, or pressure extension.

Procedure: Negative of static of 0.7210 is 0.2790.

0.5000 + 0.2790 = 0.7790.

Final reading is 0.0674.

1.0674 — 0.7790 = 0.2884.

Pressure extension = 2884.

Analysis: Static = 0.7210: Differential = 0.4000.

Machine operation: Machine uses the negative of the differential, the positive static and the counter wheel has a negative operation.

Therefore we have 0.6000 (negative of 0.4000) × 0.7210 = 0.4326.

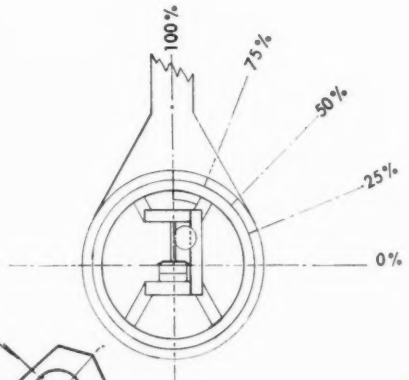
As counter wheel revolves backward (negative operation), the reading on it would be 0.5674 (the negative of 0.4326) less 0.5000, or 0.0674.

0.0674 — (0.5000 + 0.2790) = 0.2884.

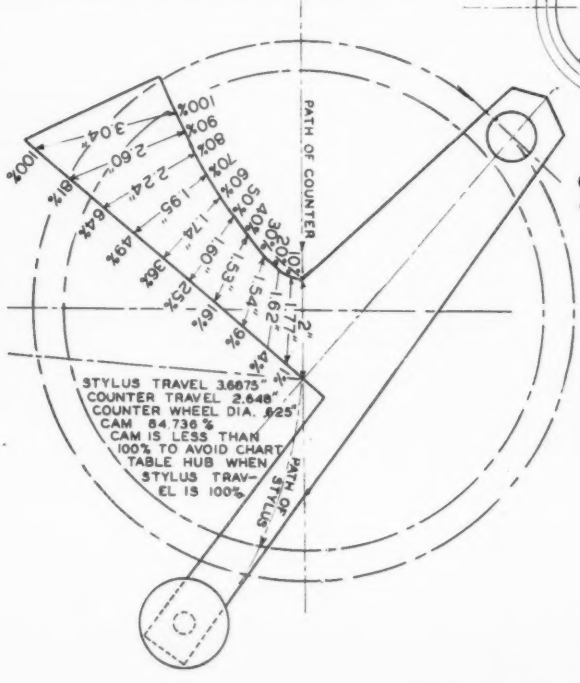
When using a factor of less than 100 per cent, the chart run must be stopped at the point of beginning with reference to both the radial and the concentric lines.

This device would consist of an aluminum base with a 13-deg. forward slope, and an overhanging support for the chart table: a stylus arm pivoted on a needle bearing; a stylus attached to arm: a cam pivoted on a needle bearing; a track for counter wheel assembly carrier; a counter wheel assembly car-

Counter assembly is so constructed that counter wheel can be placed at any angle to its line of travel, thereby permitting the introduction of any desired factor into the computation. With a static that can be ascertained at a glance, static becomes the factor, and a run of the differential results in the chart extension. If static cannot be ascertained at a glance, then a run of the static results in the factor. Computer must be stopped at point of beginning with reference to radial and concentric lines.



Counter mechanism. Inner circle makes quarter turn.


PATH OF COUNTER
STYLUS TRAVEL 3.6075"
COUNTER TRAVEL 2.648"
COUNTER WHEEL DIA. .925"
CAM 84.736°
CAM IS LESS THAN 100% TO AVOID CHART TABLE HUB WHEN STYLUS TRAVEL IS 100%
PATH OF STYLUS

Note: Chart table hub is to be set in round socket in gear shaft so that it can be turned independently of motor.

Portrayal of cam, showing its position with reference to center of chart.

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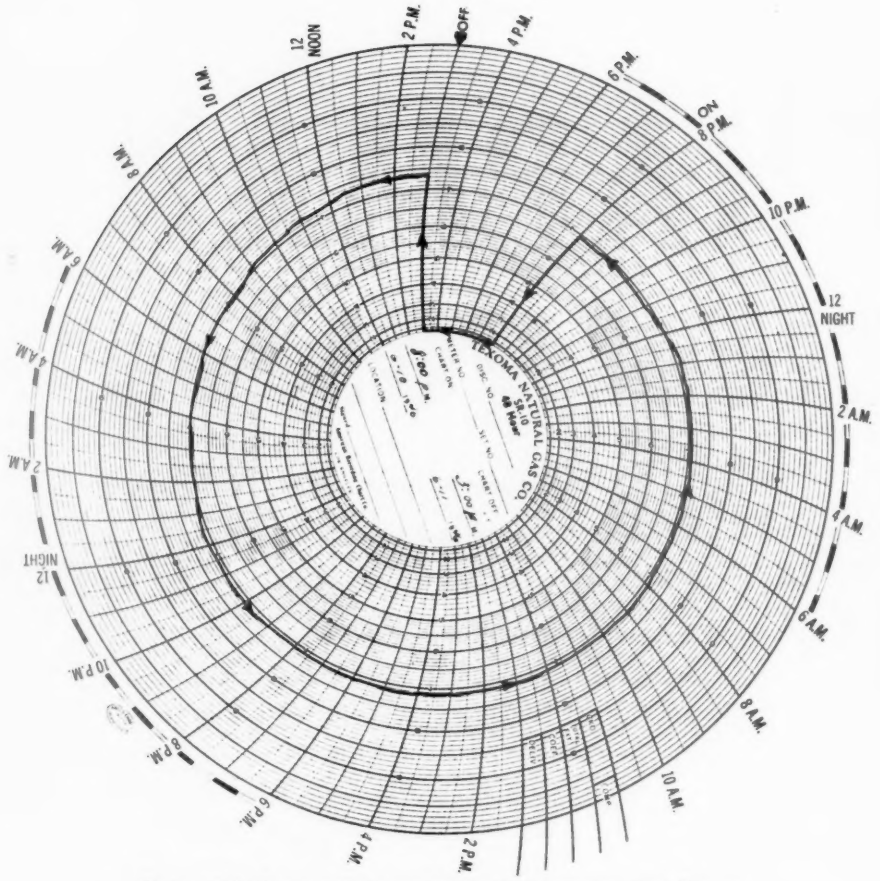

Forty-eight-hour orifice meter chart put on meter at 8 p. m. June 10, 1946, and taken off at 3:00 p. m. on June 11.

rier; a counter wheel assembly; chart table; gear and shaft for revolving chart table; and a variable speed fractional horsepower motor with rheostat control. The chart table hub is set in a socket in the gear shaft so that the table can be turned independently of the motor.

The counter wheel assembly carrier runs on a ladder type ball bearing, and contacts with cam are ball bearing. The counter wheel assembly carrier and stylus arm are held to their respective edges of cam by tension springs.

The accompanying drawing illustrates the cam and its pivot point with reference to the center of the chart. It also shows the path of radial travel of the counter assembly and stylus. All mechanism is under the chart table except the counter wheel assembly and stylus, which operate on the chart surface.

It is the opinion of the writer, as well as the opinion of other accountants and engineers, that the original chart record should not be obscured or in any way marred. Therefore, a non-recording stylus is to be used in connection with the electrical planimeter.

The writer is also the inventor and the owner of an orifice meter chart calculator that will compute the *volume of gas* in one operation. The device outlined herein is for use in those offices where it is thought a large expenditure cannot be justified for equipment for orifice meter chart computation.

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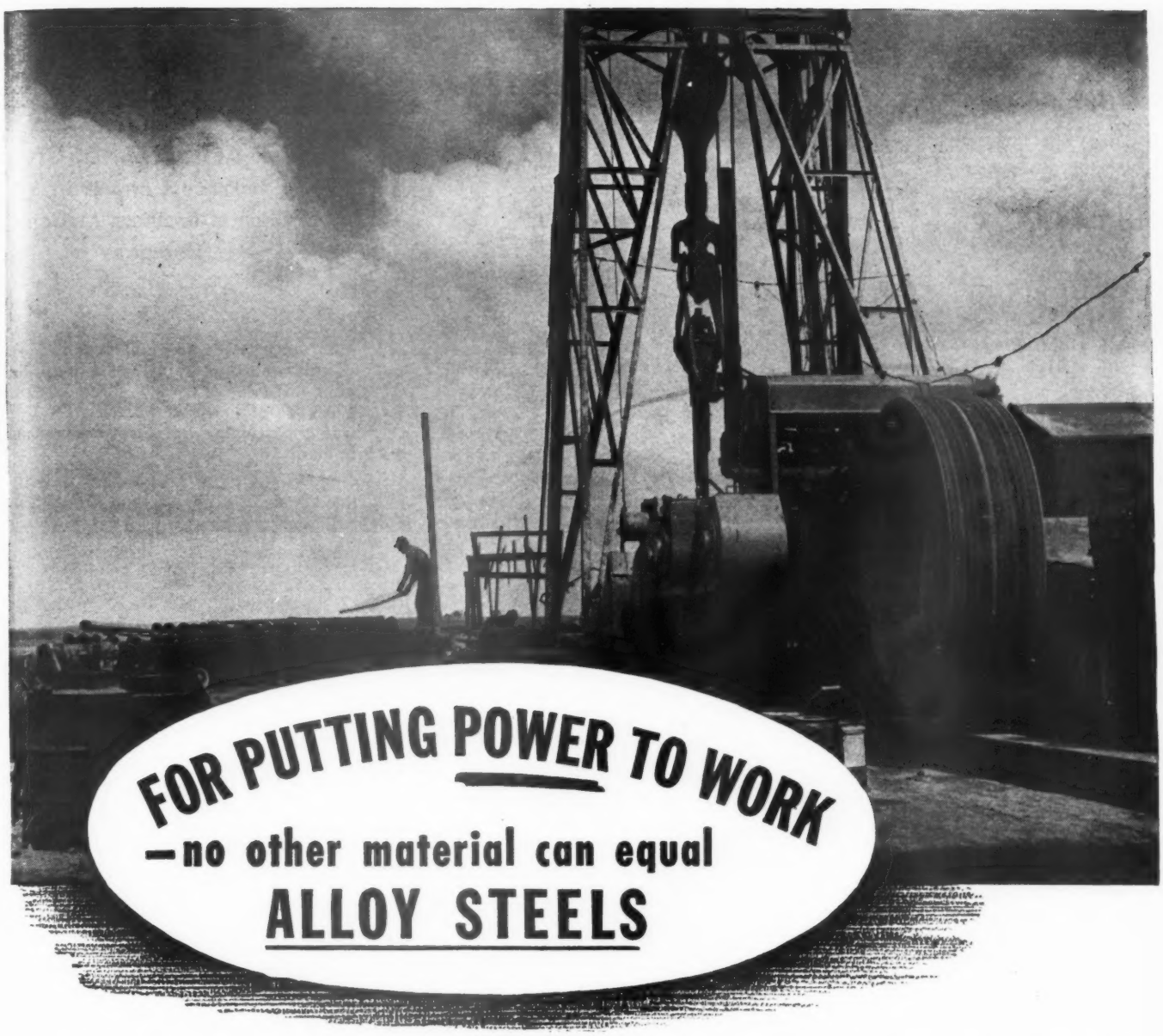

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Evaluation of absorber operating efficiency*

By **E. G. RAGATZ,**
Consulting Engineer
and
J. A. RICHARDSON
Process Engineer
Bechtel Brothers McCone Company

PART 2—Conclusion

TYPICAL examples of the straight line chart's characteristics are presented in Figs. 4 and 5†, on which we have plotted the same data previously presented in rectangular charts Figs. 2 and 3. Inspection of these latter plots shows that:

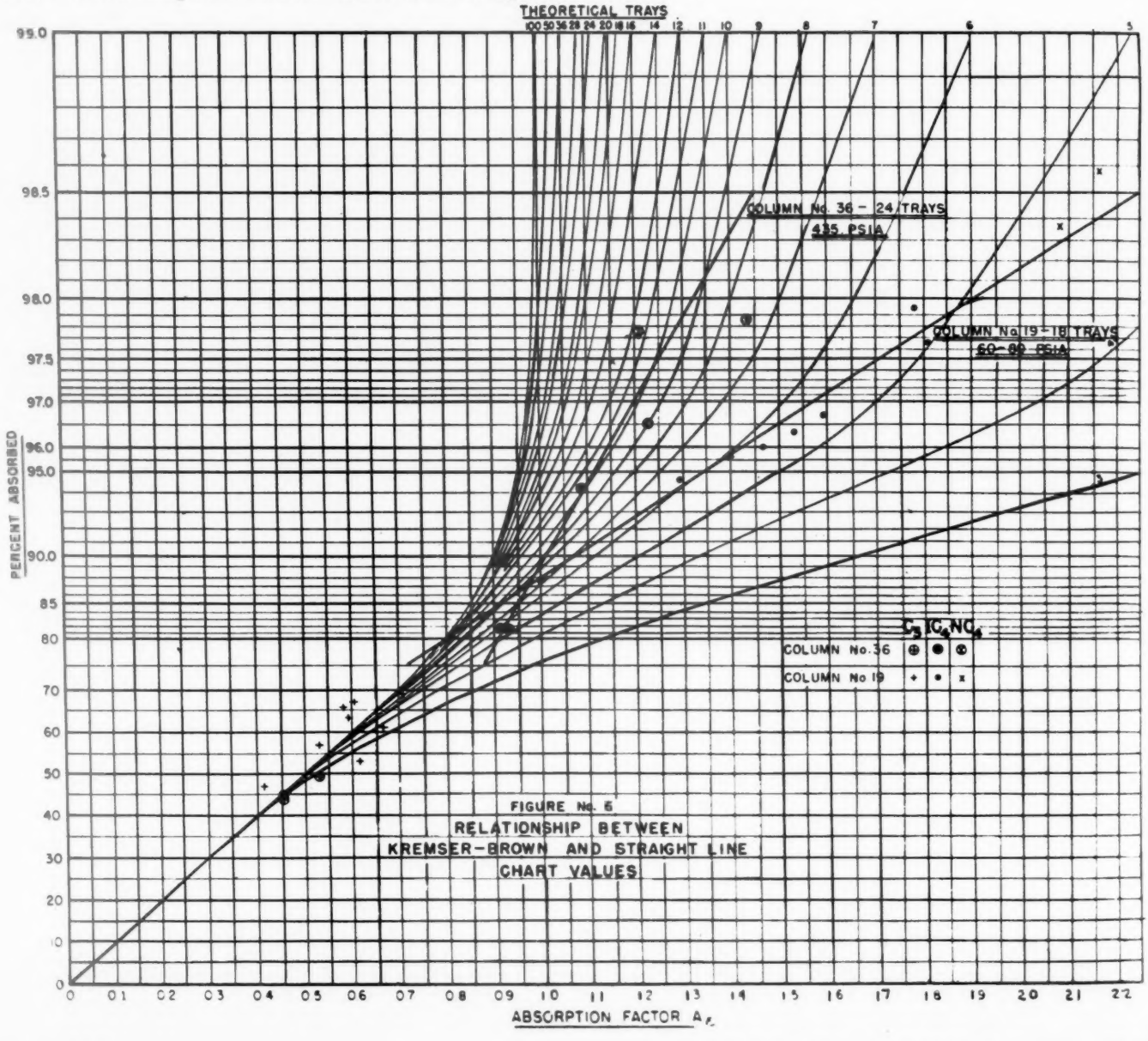
1. A majority of the operating lines on each plot can be drawn as straight lines through the indicated pressure convergence points with an accuracy well within that required for precise engineering practice.

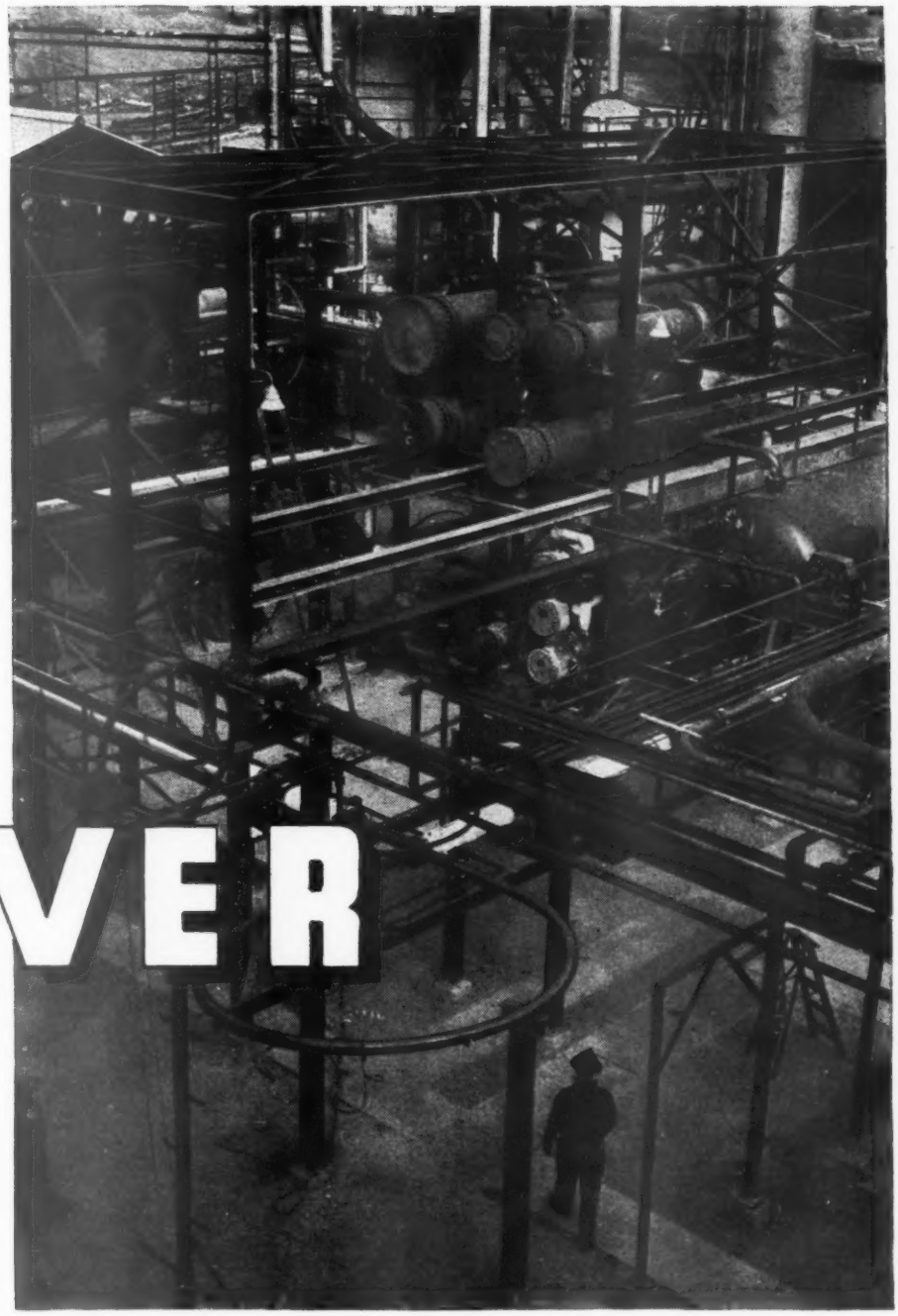
2. Where there is a conflict in the test data, as between tests 33 and 32-41-42 of column 19, or tests 15 and 36 of column 13 (Fig. 4) the "single convergence point" criteria immediately tells which particular test recovery value is in error.

3. Where there are several well defined lines of different slope for a given column, such as shown by tests 69 and

*Presented before California Natural Gasoline Association, October 11, 1946.
†First five figures are shown in Part 1.

FIG. 6. Relationship between Kremser-Brown and straight line chart values.





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74 versus 63 and 64 for column 31 on Fig. 4, or tests 38 versus 39 versus 30 for column 5 on Fig. 5, a fundamental difference in basic tray efficiency is indicated.

4. Operating lines that depart radically from the general operating pattern as with column 29 on Fig. 4, or column 20 on Fig. 5, definitely indicate serious error in the original test data.

Additional features of the straight line chart are presented in Fig. 6. Here we have plotted the operating line for column 19 from Fig. 4, and column 36 from Fig. 5, on a straight line chart to which has been added a grid indicating the "Brown per cent yield versus A_e relationship" for 3 to 100 theoretical trays. Also, the per cent key component yield from 70 per cent on down to 0 per cent have been indicated. These particular chart additions were made for the purpose of demonstrating:

1. The wide changes in Kremser-Brown theoretical tray efficiency shown by a single column operating at a given basic tray efficiency as its per cent recovery of key component is changed.

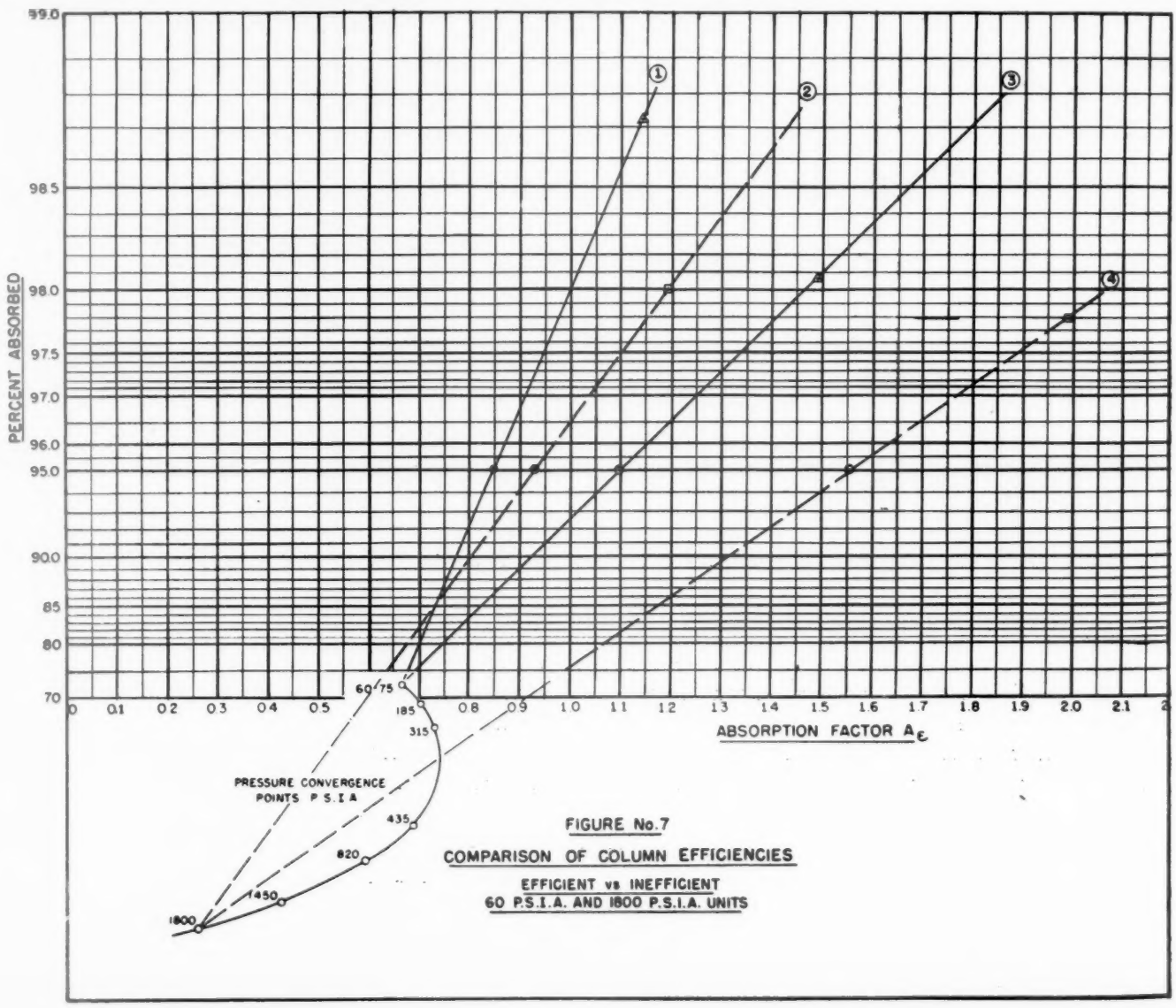
2. The marked difference in relationship existing between per cent recovery and A_e for recoveries of over 75 per cent, and under 60 per cent.

The wide range shown by the theoretical Kremser-Brown tray efficiencies of Fig. 6 are typical. Also, it should be noted that whereas 24-tray column 36 ranges through an *increasing* theoretical tray efficiency of 16.5 per cent to 44.2 per cent to 34.6 per cent in going from a 75 per cent to a 98.5 per cent key component recovery, 18-tray column 19 goes through a reverse, or *decreasing*, efficiency range of 100 per cent plus down to 25 per cent for the same key component recovery change. The magnitude and reversed direction of these two sets of tray efficiencies aptly illustrate the inadaptability of the conventional theoretical tray efficiency factor to accurate specification definition, or precise column operation comparison.

Although the test points for component recoveries below 70 per cent on Fig. 6 are somewhat scattered, it is clearly evident that one single line will well represent the average of both column operations. This observation conforms with the well understood absorber relationship that in the actual commercial column, excess trays are always present for the "under 70 per cent recoveries," and therefore such recoveries are functions of absorption factor only —and independent of actual tray number or tray efficiency.

We have previously mentioned the empirical nature of the pressure convergence points on the straight line chart. These points constitute an important feature of the chart, and their proper location is essential to the chart's accuracy. Although the present indicated locus of such points has been defined by three fairly large groups of data (averaging 67.5 lb. per sq. in. abs. 435 lb. per sq. in. abs., and 1450 lb. per sq. in. abs., respectively), and four smaller groups, there is some question regarding the authority of a portion of this material. Consequently, we may find that the presently indicated convergence

FIG. 7. Comparison of column efficiencies. Efficient vs. inefficient. 60 PSIA and 1800 PSIA



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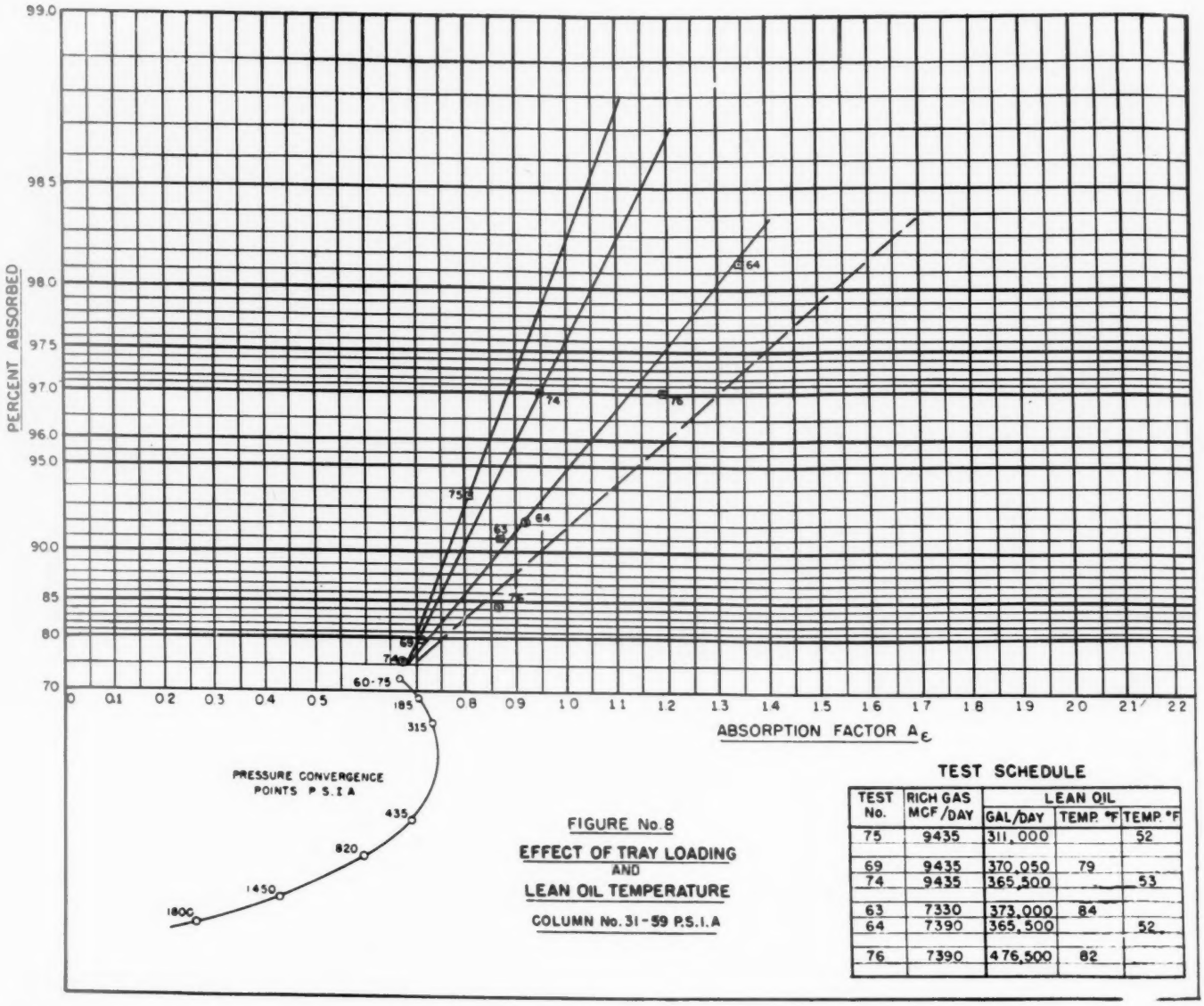


TEST No.	RICH GAS MCF/DAY	LEAN OIL GAL/DAY	LEAN OIL TEMP. °F	TEMP. °F
75	9435	311,000		52
69	9435	370,050	79	
74	9435	365,500		53
63	7330	373,000	84	
64	7390	365,500		52
76	7390	476,500	82	

FIG. 8. Effect of tray loading and lean oil temperature. Column No. 31-59 PSIA.

point locus will be subject to some change as additional authoritative data become available.

In connection with this locus, it will be noted that the individual pressure convergence points shift substantially with pressure. This shifting is in full agreement with another well understood absorption law, namely, that the absorption column's relative selectivity steadily decreases with increased pressure.

On Fig. 7 we have illustrated the operation of this law as applied to a pair of low and high pressure columns. In this figure, lines 1 and 2 represent two high efficiency units operating at 60 lb. per sq. in. abs. and 1800 lb. per sq. in. abs., respectively, whereas lines 3 and 4 represent two similar pressured low efficiency units. For such pairs of columns (with each pair operating on the same quality lean oil and rich gas) the per cent nC_4 recoveries and relative lean oil rates associated with a common 90 per cent iC_4 recovery, are indicated thus:

Relative oil rates and nC_4 recoveries at 90 per cent iC_4 recovery.

	Per cent nC_4 recovery	Relative oil rate, per cent
60 lb. per sq. in. abs.:		
Efficient column	98.71	100
Inefficient column	98.07	130
1800 lb. per sq. in. abs.:		
Efficient column	98.00	100
Inefficient column	97.80	170

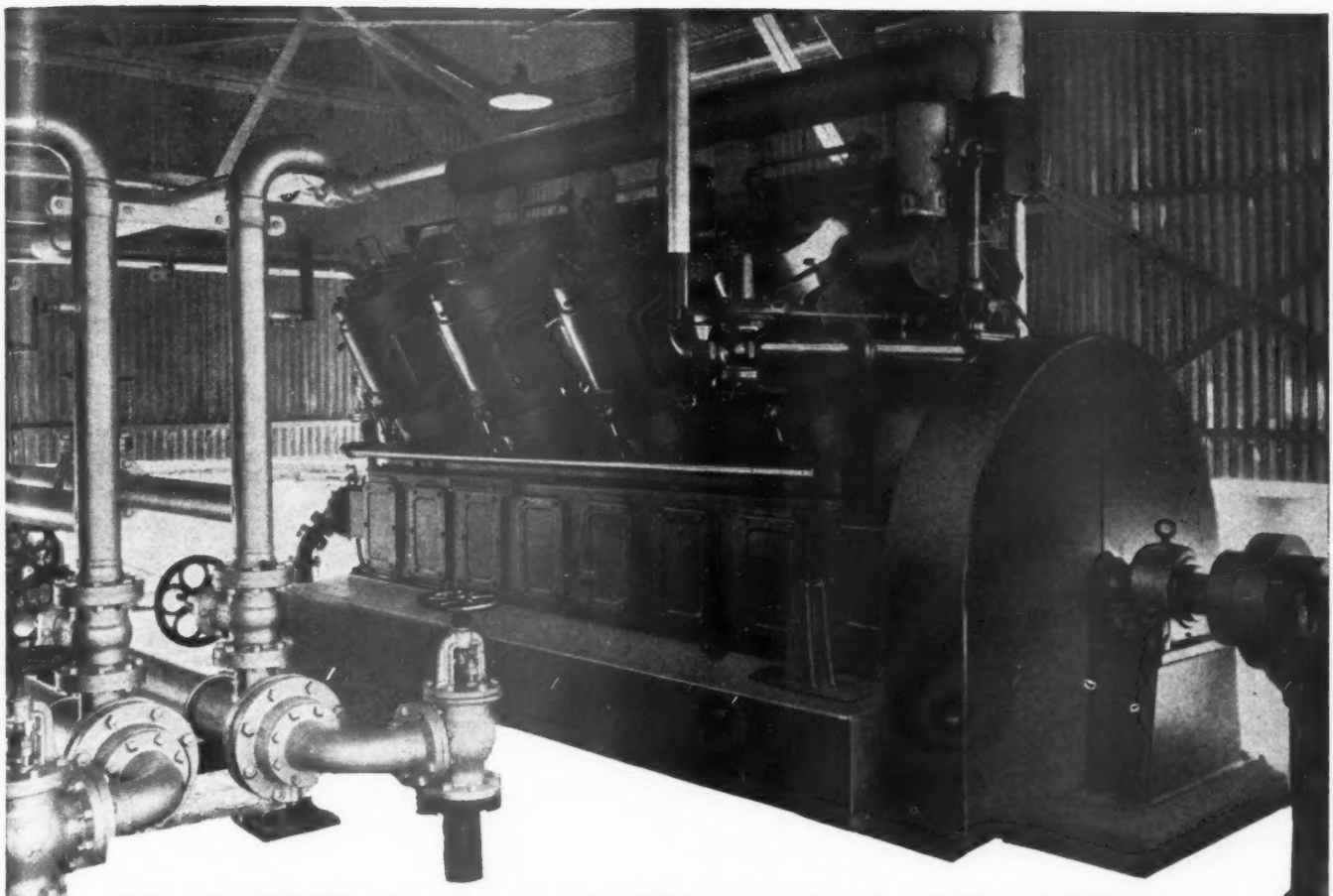
These figures not only indicate the differences in relative selectivity existing between high and low pressure columns, but also emphasize the importance to oil circulation of employing high efficiency column equipment, particularly for the higher pressure operations.

The effect on the straight line operating curves of materially changing the lean oil temperature or tray loading at a given column is shown on Fig. 8. Inspection of this figure (covering the operation of 59 lb. per sq. in. abs. column) shows that the basic tray efficiency as measured by the slope of the operating

Improved oil shale operation methods

The Bureau of Mines has disclosed it has developed an improved method of assaying oil shale and is employing it successfully at its new research laboratory at Laramie, Wyoming.

Dr. R. R. Sayers, director, said the method, employing a modification of the Fischer cast-aluminum retort, commonly used in low-temperature coal carbonization, takes two-thirds less time, uses a smaller sample, permits more precise control of the retorting operation, and increases the volume of oil recovery from shale by 5.4 per cent. Oil shale is ranked as one of the major potential sources of liquid fuel.



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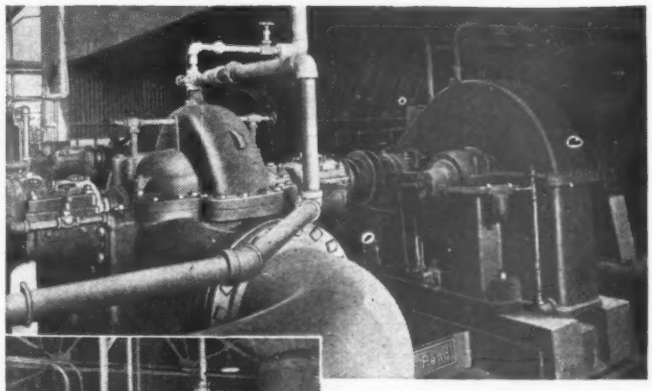

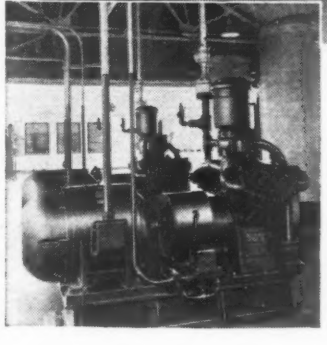

Above: In addition to these engine-driven pumping units there are three electric-driven pumps of same size as well as two 7½-hp vertical 4-stage Motorpumps.

Left: Two Type 40 Two-Stage, Air-Cooled, Air Starting Compressors in the same plant.

Two 370-hp Ingersoll-Rand Type PVG gas-engine pumping units each handle 7,000 gpm of cooling-tower water at the Winnie, Texas gasoline-absorption plant of Glenn H. McCarthy Gas & Oil Corp.

These engines are of the 4-cycle, V-angle, multi-cylinder design, well known for its dependability and economy of operation in oil fields and refineries around the world. Operating at 400 rpm, each drives an Ingersoll-Rand 16" Class ALV single-stage pump at 1150 rpm through speed-up gears.

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line remained fixed for wide changes in lean oil temperature as long as the tray's physical loads were held substantially constant. On the other hand, substantial changes in the physical loading of the column resulted in corresponding changes in its basic tray efficiency.

In this clean-cut distinguishing between changes in physical tray action, and changes in lean oil temperature, the straight line chart thoroughly reflects good theory.

Fig. 9 reveals the effectiveness with which the straight line chart handles the intercooled absorber operation. For this particular test series the lean oil and rich gas rates were held substantially constant, and the number and location of active oil coolers were changed. As shown on the chart, this control resulted in a single operating line for those four tests which utilized coolers in the top 75 per cent of the column. For the fifth test (No. 204) wherein cooling was employed near the bottom of the column, a second, less efficient, operating line is indicated. Here again the straight line chart reflects a well understood absorption law, namely, that the most effective cooling is that applied to the upper section of a column.

We have previously indicated that a column's relative effectiveness is measured by the slope of its operating line. The reason for this, of course, resides in the factors composing A_e—which for small changes in column control, make A_e substantially proportional to the lean oil circulation rate. Under these circumstances, the steeper the operating line the smaller the value of A_e, and the smaller the quantity of lean oil required for a given key component recovery. Consequently, the column that exhibits the steepest slope for a given operating pressure is the most effective, and when several columns containing the same number of trays are concerned, the most efficient.

When this efficiency relationship is coupled with the fact that all operating lines for all columns can be drawn as straight lines passing through unique pressure focal points, it is seen that only one additional operating point need be located to identify completely a column's effectiveness (or efficiency). If this additional point is then located on a conveniently chosen "per cent recovery" reference line, the column's effectiveness at any given pressure can be accurately identified by a single "efficiency rating" number, i.e., by the value of A_e for that particular reference per cent recovery. In our work we have chosen 95 per cent for this reference base.

Proper utilization of these straight line chart relationships makes it possible to:

"Accurately specify, and check, a column's effectiveness without the need of running on a precise quality of feed stock, or effecting a precise recovery of a given key component."

The many advantages inherent in such a specification flexibility are, of course, obvious.

Back of the specification advantages lies another extremely interesting possibility of the straight line chart, namely:

"Accurately comparing the operation of a given column with the best of com-

FIG. 9. Effect of tray intercooling. Column No. 38-315 PSIA.

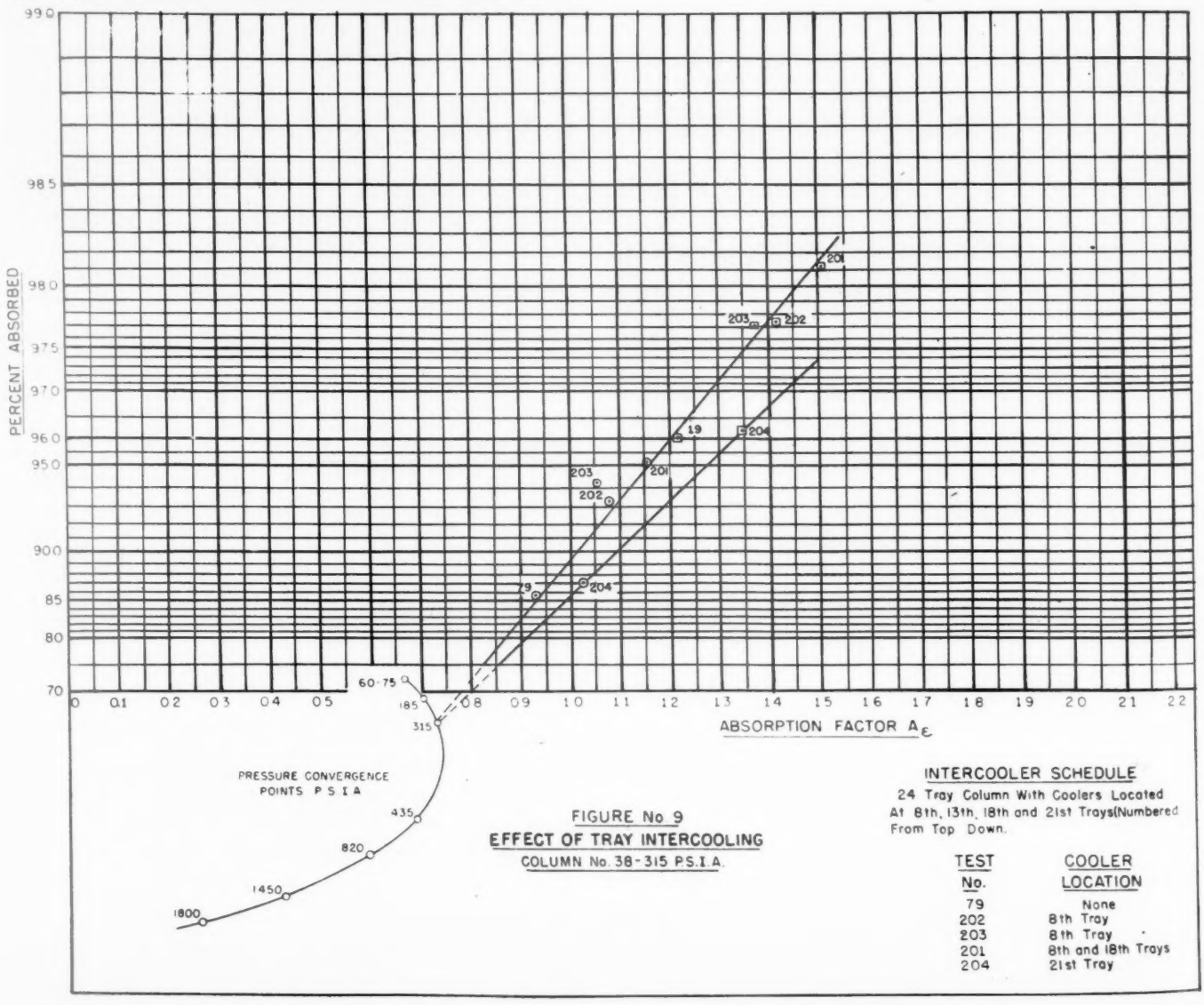

FIGURE No 9
EFFECT OF TRAY INTERCOOLING
COLUMN No. 38-315 P.S.I.A.

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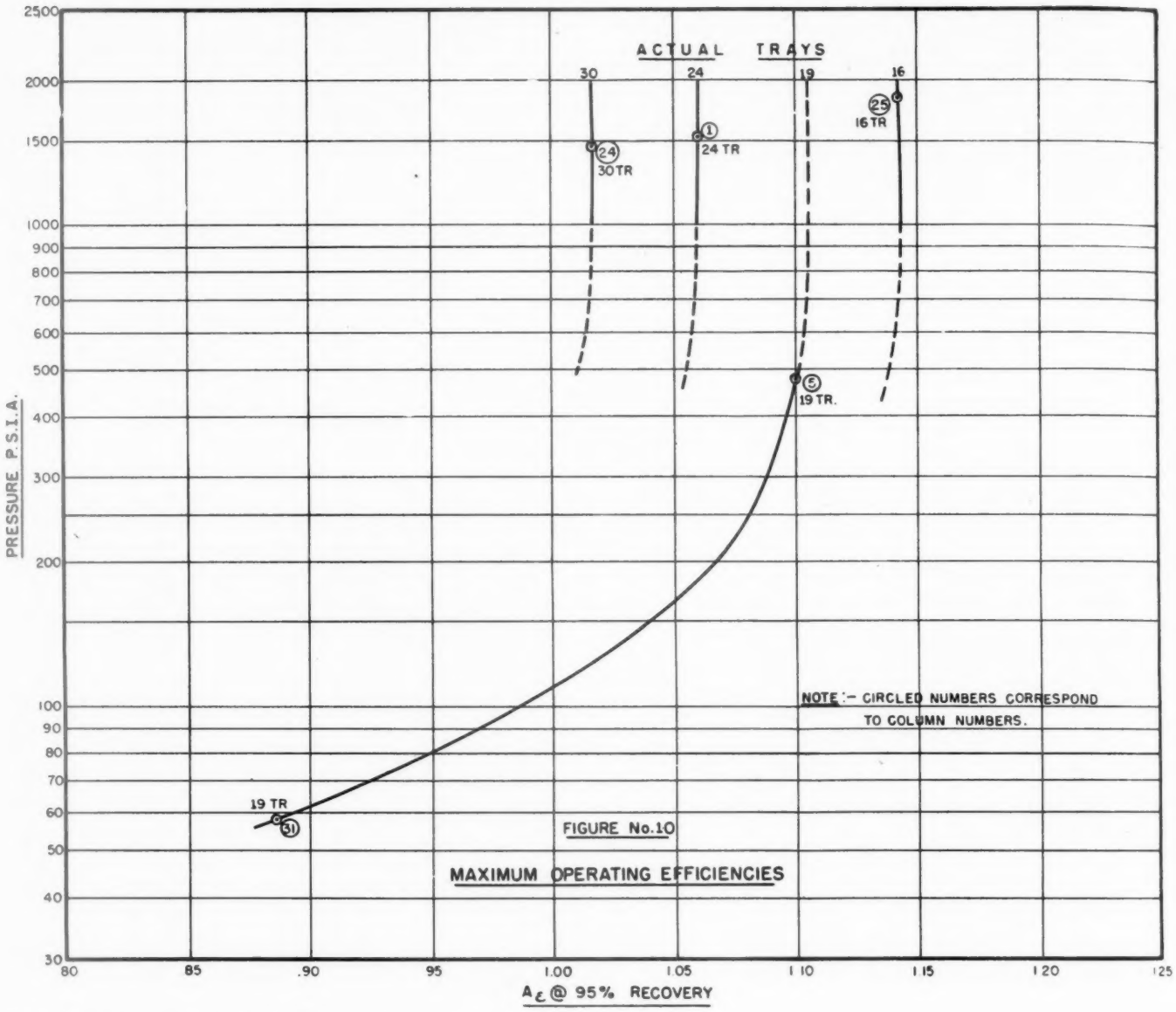

FIGURE No.10

MAXIMUM OPERATING EFFICIENCIES

FIG. 10. Maximum operating efficiencies.

mercial units without having to run the column in question under any particular pre-set conditions of control."

Unfortunately, full attainment of this second goal is dependent on the analysis of a great deal more operating data than appears available at the moment; however, we have made a start in this direction with the results shown on Fig. 10.

On this chart we have plotted values of A_e at 95 per cent recovery against the log of the absolute operating pressure for the most efficient columns studied to date—with the number of trays utilized in each column being noted, and lines of fixed tray number being drawn through them. If sufficient high efficiency data were available, such a chart would clearly specify the complete range of operation of the industry's most efficient units. In our case, however, it merely indicates what may be accomplished in the future.

Our meager results are presented for what they are worth. Although we have no means of knowing whether or not the subject columns were operating at approximately the same relative efficiency, it is interesting to note that a rough pattern is established that exhibits the proper relationship between A_e requirements and number of trays employed. Although crude, it is certainly a first step in the right direction, namely, to make it possible for the plant operator quickly and accurately to determine whether or not his own plant equipment is "up to the industry's best standard," and if not, in what degree it departs from that standard.

To us, the most outstanding feature of this first attempt at an overall industry column comparison was that out of some 40 columns analyzed, only five units fully qualified for inclusion in the maximum efficiency grid, with two or three others presenting some evidence that with more complete testing they also might have made the grade.

In other words, only 20 per cent at the very outside of all columns studied were operating at efficiencies approximating the industry's best indicated standard at the time of testing, which fact is certainly a challenge to both the operator and the designing engineer.

In meeting this challenge, an accurate and consistent measure of column performance is the first essential. For this service we offer a new process tool, "The Straight Line Chart," confident that it will live up to its initial promise of consistently evaluating the absorber performance throughout its operating range.

In closing, we wish to acknowledge our heavy indebtedness to the many individuals and companies who have so generously contributed data to this study, and without whose help this work could never have been accomplished.

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4. Horton, George, and Franklin, W. B., *Ind. Eng. Chem.*, 32, (1940).

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Fig. 1793—125-pound Iron Body Bronze Mounted Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, bronze seat rings and taper wedge solid disc. Also available in All Iron.

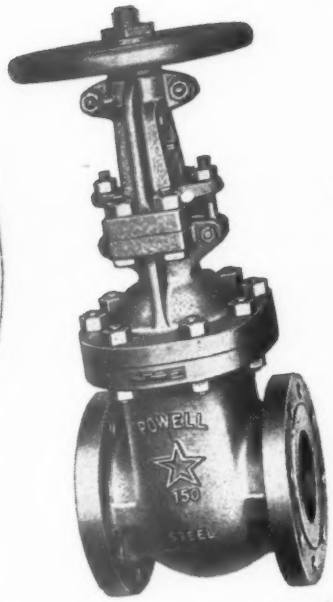

Fig. 1503—Class 150-pound Cast Steel Gate Valve. Has flanged ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc.

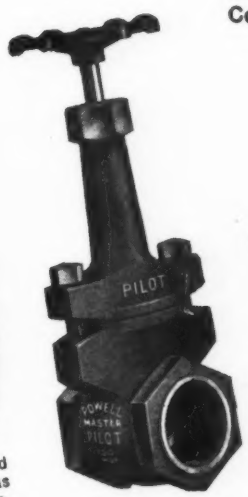

Fig. 1460—Iron Body Bronze Mounted "Master Pilot" Gate Valve. Screwed ends, rising stem, bolted flanged bonnet and taper wedge solid disc. Also available in All Iron.

Fig. 3003—Class 300-pound Cast Steel Gate Valve. Has flanged ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc.

Fig. 190—150-pound Iron Body Bronze Mounted "Irenew" Globe Valve. Has screwed ends, union bonnet and regrindable, renewable wear - resisting "Powellium" nickel-bronze seat and disc.

Fig. 6061—Class 600-pound Cast Steel Swing Check Valve with Ring Type Joint End Flanges.

POWELL VALVES

The transportation of natural gas*

By **D. A. HULCY**, *President*, Lone Star Gas Company

THE subject of this discussion is one that would require a long discussion if anything like full coverage of the subject were to be obtained. Since this is so, it will not be my purpose to attempt a full discussion but rather to call your attention to certain situations and circumstances that seem to require additional consideration and attention by our industry.

It is quite natural for us to devote our attention at any time to the problems that currently are the most pressing and to permit our study of these current problems to absorb our thoughts at the expense of matters that are of a more fundamental and continuing nature.

What I should like to do, therefore, in this discussion is to offer certain comments on problems of general but fundamental nature that exist in the business of transporting natural gas. There is little doubt that one of the primary factors that must be dealt with in a business that transports natural gas, whether intrastate of interstate, is the one of regulation of the business by public regulatory authority. On other occasions in the past I have made comment on regulation and its effect on our business but, under the risk of being repetitious, I wish to state my convictions in regard to what our attitude should be toward regulation, and conversely what the attitude of regulatory bodies should be toward us.

We must recognize and appreciate the necessity of proper governmental regulation of a business in which the public interest is so vitally involved. Rates for household use should be fixed with due regard to the cost of service, both capital and operational, and to the hazards of the business. Customers should be served without discrimination, and every reasonable control should be exercised that would tend to make service adequate and continuous. Accounting classifications should be prescribed and their use enforced in order that the pertinent facts of all phases of the business might be readily ascertainable. All securities offered for sale to the public should be subject to close scrutiny and governmental approval. The elimination of the waste of gas should be effected through the medium of laws and by means of the enforcement of regulations, which should be administered by men who have an intimate knowledge of local conditions and a proper appreciation of all the economic adjustments that a successful conservation program requires.

Granting all this, the fact remains that in the natural gas business, more than in any other type of public service, the quickening spirit of the enterprise is to be found in the free exercise of managerial discretion in originating and in passing final judgment on those vital matters upon which success or failure so frequently depend and which so effectively differentiate the natural gas business from all other utilities subject to public regulation. Human foresight and ingenuity are not adequate to provide a basis for the promulgation of hard and fast rules and regulations that will be applicable to highly variable basic conditions—conditions that create managerial problems that cannot be solved by the application of formulae worked out in advance.

Among other things that are always uppermost in the minds of those charged with the operation of a natural gas transportation system, there is nothing more important than the requirement for a fully adequate source of gas. No one will question the fact that a natural gas transportation system must have available for its use, if it is to operate in a healthy manner, sources of gas supply that may be depended upon to supply the needs of customers on a current basis and that will provide sufficient gas over the period of time that is long enough to insure a firm basis for operation. What the transporter of gas is concerned with primarily is a supply situation that is healthy from the standpoint of his system and its customers, regardless of whether circumstances have required him to become a producer of gas in one or more of the fields from which he takes gas. In many instances the transporting company depends upon fields where both it and other producers own wells and have made substantial investments in producing property. It is decidedly the primary desire of the transporter that such a field, as a whole, should be so operated and maintained that the greatest amount of gas will be recovered therefrom. This desire and self interest, if you please, should, and in most instances does, cause the transporting company to forego special temporary advantages in producing its wells when the overall and long range welfare of the field requires this action.

This leads us to a consideration of two problems that confront the transporter of gas in regard to his source of supply, and although these problems may be classified as production problems they, nevertheless, are serious and fundamental in the business of transporting natural gas. The first of these arises in connection with the proration of gas production in various fields. The process of proration has developed to a considerable degree and there is little doubt that the proration of gas withdrawals among wells and leases within an individual field will become more and more general practice until it is universal. There are two worthwhile objectives to be achieved by a proper proration procedure within a field. One of these objectives is to cause the field to be so operated that it will produce the greatest possible amount of gas. The second objective is to achieve, consistent with the first objective, the distribution of withdrawals among various properties in the field on a basis that will protect the correlative rights of the owners in the field.

It is necessary in the achievement of each of these objectives that a field be completely developed on a reasonably uniform basis, but this fundamental consideration has received heretofore less attention than it deserves. To be more specific, the spacing of wells within a field is usually controlled by the effect of a proration formula rather than by any specific spacing regulations. A proration formula should be devised and applied in such a way as to reasonably assure the complete development of the field within a reasonable length of time on a well spacing basis that is as uniform as possible. If this is done with due consideration to the economic factors that control, we will see in the future fewer and fewer fields with areas that remain undeveloped throughout the life of the field, causing underground waste of gas. Also, we will see fewer owners who fail to realize income from properties that would be productive if they could be drilled.

It would be far better for wells to be spaced too widely in the early life of a field in order to insure complete development on a uniform basis than to space the early wells too closely at the cost of leaving portions of the field undeveloped forever. There have been cases where fields were never fully developed because of an initial spacing pattern that placed wells too close together, and in these cases gas was or will be left underground not subject to recovery. In such cases, pertinent questions might be—"Whose correlative rights are being protected? Have we not forgotten the owner who fails to obtain production because economic limitations and initial well spacing that is too close have made complete development impossible?"

Finally, if an initial wide spacing program fails to provide a sufficient number of wells after complete development has been achieved on that pattern, additional wells can be drilled, but unfortunately no method has yet been devised for moving wells when it happens in a particular case that the initial spacing pattern is too close to achieve complete develop-

*Presented before Independent Natural Gas Association of America, Fort Worth, Texas, November 22, 1946.

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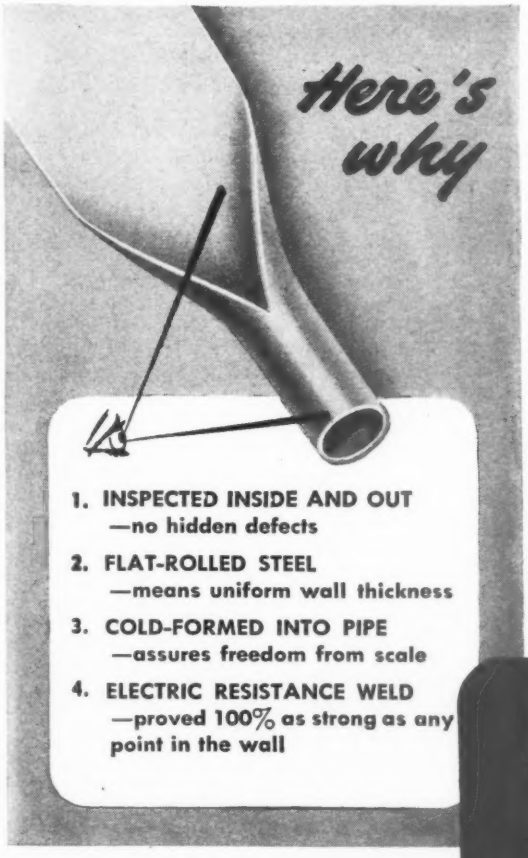
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ment under the economic situation that exists in the field. These remarks about well spacing and proration have been made primarily in respect to the production of gas; but it is my thought that the same reasoning would properly apply in respect to the production of oil.

Another proposition about which I should like to make comment is intimately related also to the gas transporter's supply situation and to gas proration. The practice of venting casinghead gas has received a considerable amount of attention in various quarters in recent times and scarcely less attention has been devoted to measures to reduce the amount of this venting by means of gas transporters taking and utilizing this gas.

There is no doubt that the gas transporter may utilize this gas under proper circumstances and that it is to his advantage to do so. It is true, however, that in much of the discussion that has been had about means of persuading or requiring the transporter to take casinghead gas, there has been a tendency to forget that this gas belongs to the producer and is vented by him as a pure incident to the production of oil, which is the matter of primary concern to him.

It is frequently the case that the producer is willing to make his casinghead gas available only on a basis that will in no wise alter his oil-producing procedure, presently used or anticipated for the future. The result of this situation is that the producer usually feels that the adaptation of his operations to the requirements necessary to permit the transporter to take the gas is unreasonable and unprofitable to him; and that it is the duty of the transporter alone to fit his operations to the existing circumstances. On the other hand, there may exist in the attitude of some gas transporters an apparently unjustifiable degree of resistance to the taking of casinghead gas.

The one approach to this problem that offers a rational solution in a healthy manner is the one wherein both the producer and transporter recognize that a joint problem exists—a problem that may be jointly solved in many instances to the mutual benefit of the parties involved. It is absolutely necessary, however, that the joint approach to a solution be undertaken with a full realization on the part of the producer of the transporter's situation and operating requirements, and conversely the transporter must be aware of the operating requirements of the producer. In any case, there should be some adjustments on each side of the proposition and these should be undertaken in good faith with a full realization of the mutuality of the deal and of the benefits that will accrue to both of the parties.

There is no need to discuss the controlling operating requirements of the parties in the sale and purchase of casinghead gas because such requirements have been fully stated on other occasions, although they may not have received heretofore the consideration they deserve.

The essence of what I have said about the casinghead gas problem is that it is not a question of the oil industry versus the gas industry, but that it is in fact a problem for both. It is a problem that by long odds should be solved by petroleum industry action without the imposition of rigid regulatory formulae.

There is another matter about which I should like to offer comment. Although it has virtually nothing to do with the mechanics of the transportation of natural gas, it is, nevertheless, of paramount importance to any working organization in our American economy. I refer to the pressing need that now exists and that always has and always will exist for a more realistic training of the supervisors in our working organizations. The training and assistance that we have made available in the past to supervisors throughout our organization have been essentially limited to the mechanical aspects of the work. The result has been that we have neglected to a great degree to provide assistance to our supervisors in the most difficult and complex phase of their working responsibilities. I refer to the art or science of human relationships between the supervisor and his working subordinates.

We need to assist each and every one of our supervisors in his efforts to cope with this complex problem because it can be demonstrated that no one is automatically and naturally a perfect supervisor when the human aspects are considered in his job. A supervisor may know his job mechanically, he may have common sense and a fair minded attitude and he may proceed with all good intention toward his subordinates but he cannot be a uniformly successful handler of people unless he consistently and courageously utilizes sound principles to govern his human relationships. We can and we should provide such principles for the use of our supervisors and we should aggressively undertake to demonstrate how well they will work, and finally we should see that they are applied.

This may sound as if it is a general approach to an intangible and visionary solution of a pressing problem but because of the limitation of time my discussion cannot embrace a full exposition of this matter. I justify mentioning it on the basis of suggesting a thought that probably is not new to you but to which, I am convinced, we have all given too little attention. I also justify mentioning it for the reason that the results obtained by us in pursuing this matter to a limited extent up to now have been extremely encouraging. These results have been obtained by some intensive work with our supervisors and we feel that the value to our organization that has already accrued is far out of proportion to the effort expended. We expect results from this work to be cumulative as the program proceeds and there is great promise for the future.

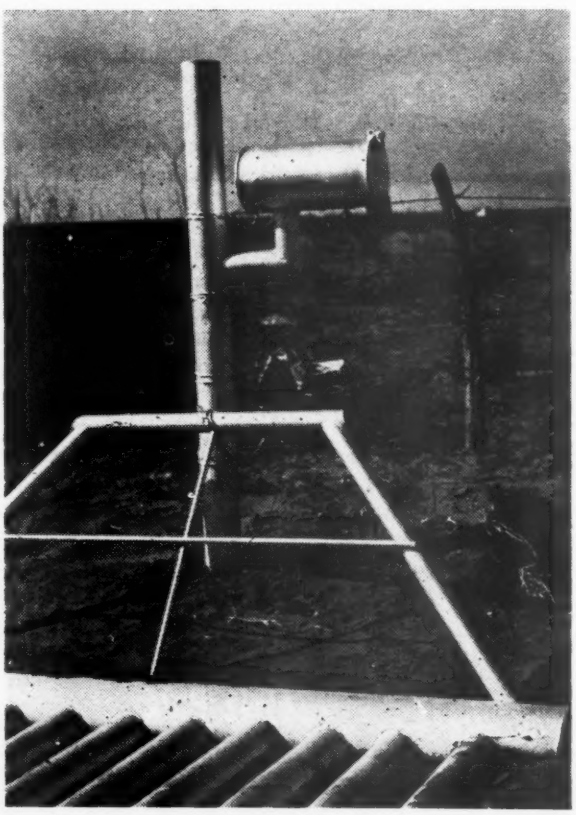
Finally, I should like to offer my commendation upon the efforts of this association to pursue a course of constructive action in the affairs of our industry. I am sure these efforts will continue and I trust that our meeting will be, in truth, a forum where industry may approach its real problems with joint effort and open eyes to work toward healthy solutions. ★★★

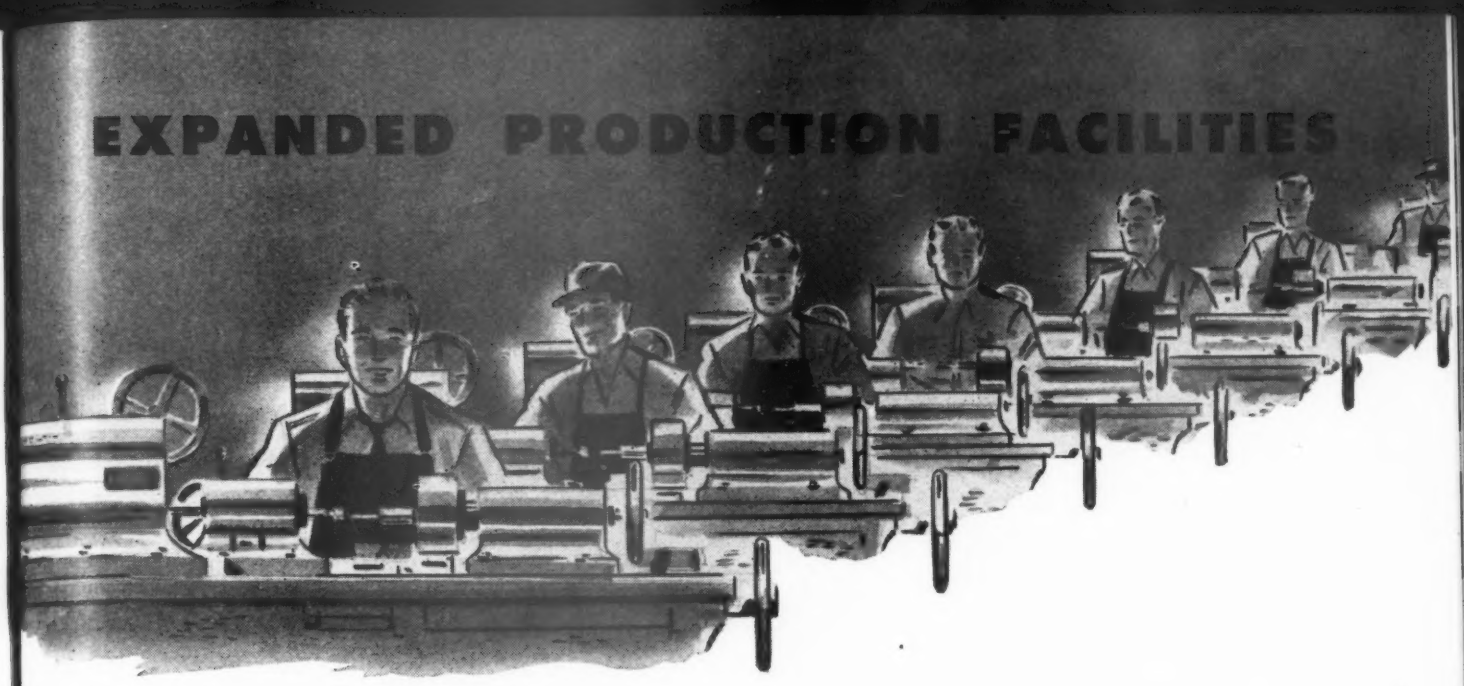
Mail box for lease reports

RECENTLY this kink was noticed doing silent duty on a West Texas lease for a lease worker's reports.

The 6-in. pipe container is 18 in. long and blanked off at the back. A hinged cover plate with slit at the front allows lease reports to be inserted and removed. The hinge is made from three links of a 1-in. link chain and the hasp is made from strap iron drilled and welded in place.

The support is a 2-in. elbow welded to the 4-in. cattle guard post, and the whole unit is painted to preserve it against weather. Lease reports are protected against wind and weather in this sturdy container. ★★★





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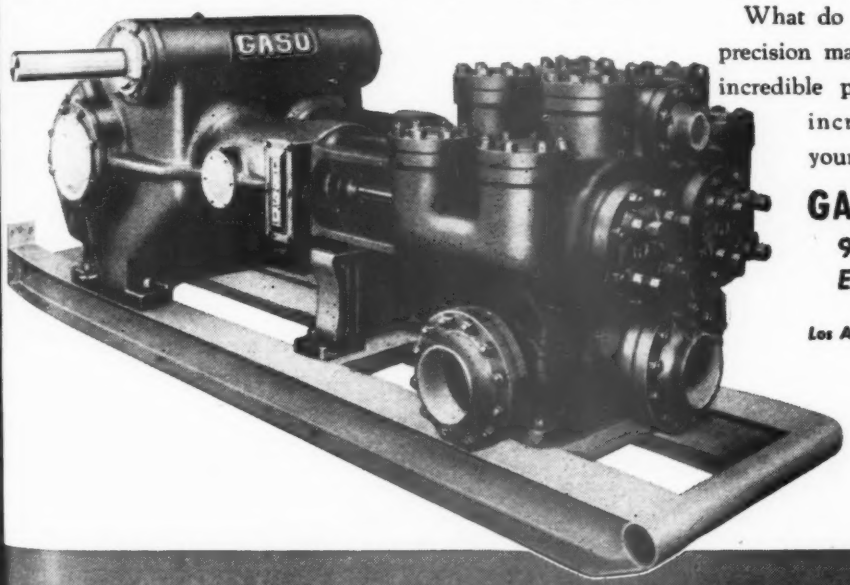

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Classification of oil discoveries and fields

THE Pacific Section of the American Association of Petroleum Geologists in 1944 formed a Classification Committee to consult with oil operators and various state and oil industry organizations for the purpose of systematizing the naming of new oil and gas discoveries avoiding duplication and confusion in naming discoveries and aiding in the selection of appropriate names for discoveries. During much of 1945 and the first half of 1946, most new discoveries have been reviewed by the committee and, if no name or an inappropriate name had been selected by the operator making the discovery, the committee suggested the name believed to be most suitable. The consultation with operators was carried out directly by the committee and through the Conservation Committee of California Oil Producers. The staff of the State Division of Oil and Gas was also consulted on names of oil fields.

It soon became apparent to the committee that some revisions of previous usage and grouping of fields would have to be made if a logical system were to attain success. The earlier efforts were very successful with respect to names of new oil fields but it was found that new pools in the older fields could not fit both the logical system proposed and the old system of listing. The meetings with the conservation committee resulted in the formation of a joint committee to revise and streamline the system of field and pool names used for statistics and allocation. The new schedule with changes from the old schedule are shown in the table accompanying this article. Any substantial changes made in the names were submitted to field engineering committees and the State Division of Oil and Gas for their criticism and approval. It was apparent in the early stages of this work that a perfect revision in strict accord with the definitions was not possible nor necessarily desirable. Effort was directed toward making a compromise revision that would result in a logical and useful listing of pools with the least possible change in names and in manner of carrying statistics. Very possibly other changes will become necessary particularly as new fields and areas are discovered or become merged. These changes will be made by periodic studies of the joint committee. Proposed names for new pools will be examined for suitability, possible conflict with names used for other areas, and conformance to the ideal scheme for their selection. If the name proposed by the operator conforms to these standards it will be accepted but when a conflict arises with a previously used name or some other important reason, the joint committee will aid in selection of a more appropriate name.

The joint committee emphasizes that this work is directed toward a more logical system of naming of discoveries and there is no desire to usurp the time honored privilege of the discovering operator to the choice of the name for his discovery, but rather to aid the operator in choosing the most suitable name.

The work also showed a need for definitions of oil field divisions and groupings and a standard method of selecting names for discoveries. The accepted terms and definitions are as follows with a more complete discussion of meaning and manner of selecting names later:

Pool

Definition: An accumulation of oil or gas with interstitial water in a single, separate, pressure-connected reservoir or a number of such accumulations if commonly produced without segregation by the same well.

Examples: Kettleman Eocene, 11-2 Pool, Fault Block II Ford, Bell D-7, Hamilton, etc.

Area

Definition: A single continuous territory underlain by one or more pools that form a portion of a field that can be distinguished from the remainder of the field geographically.

Examples: Earl Fruit Area, Surf Area, Republic Area, etc.

Field

Definition: A single territory underlain by one or more pools or a territory consisting of two or more areas that may be separated by limited barren gaps.

Group

Definition: A number of oil fields forming a convenient unit readily segregated geographically from other fields or groups.

Example: Mount Poso Group (Mt. Poso, Baker, Dorsey, Dominion, etc.) Ventura Group (Rincon-Padre-San Miguelito-Ventura Ave.) Coalinga Group (Pleasant Valley, Coalinga Nose, Westside, etc.)

District

Definition: A natural geographical unit that permits a convenient grouping of fields.

Examples: Santa Maria district, Santa Clara North district, Central Valley district.

Region

Definition: A large territory that permits convenient geographical grouping of fields and districts.

Examples: San Joaquin Valley, Coastal Region.

Certain other terms that are sometimes confused with "pool," are as follows:

Zone

Definition: Strata that locally contain oil in the porous layers and usually comprise the section open to production in a normal well completion.

Examples: Stevens, Alamitos, 7th Callander, Miley, etc.

Sand

Definition: Sand as an appended term is synonymous with zone except it is usually a nearly continuous sand body with fewer shale partings.

Examples: Wharton, Vedder, Meyer.

Interval

Definition: The portion of a zone open to production in a well.

Remarks: The interval may vary from well to well. The term has been used when applied to a field as the portion of the zone that is oil saturated—especially the vertical extent of the oil pool.

Formation

Definition: Formation is a unit of strata of considerable areal extent and in oil field usage is nearly synonymous with zone except that it commonly bears a name derived from surface geological work and sometimes may include more than one zone.

Examples: Repetto, Temblor, Vaqueros, Chanac, Etchegoin, Monterey, etc.

Reservoir

Definition: A continuous space made up of the interstices in a sand, fractures in chert, or the like, occupied by oil or gas with interstitial water, together with the active edge water to the limits of its pressure connecion.

Examples: Gatchell Reservoir, Lakeview Reservoir, etc.

Fault block or block

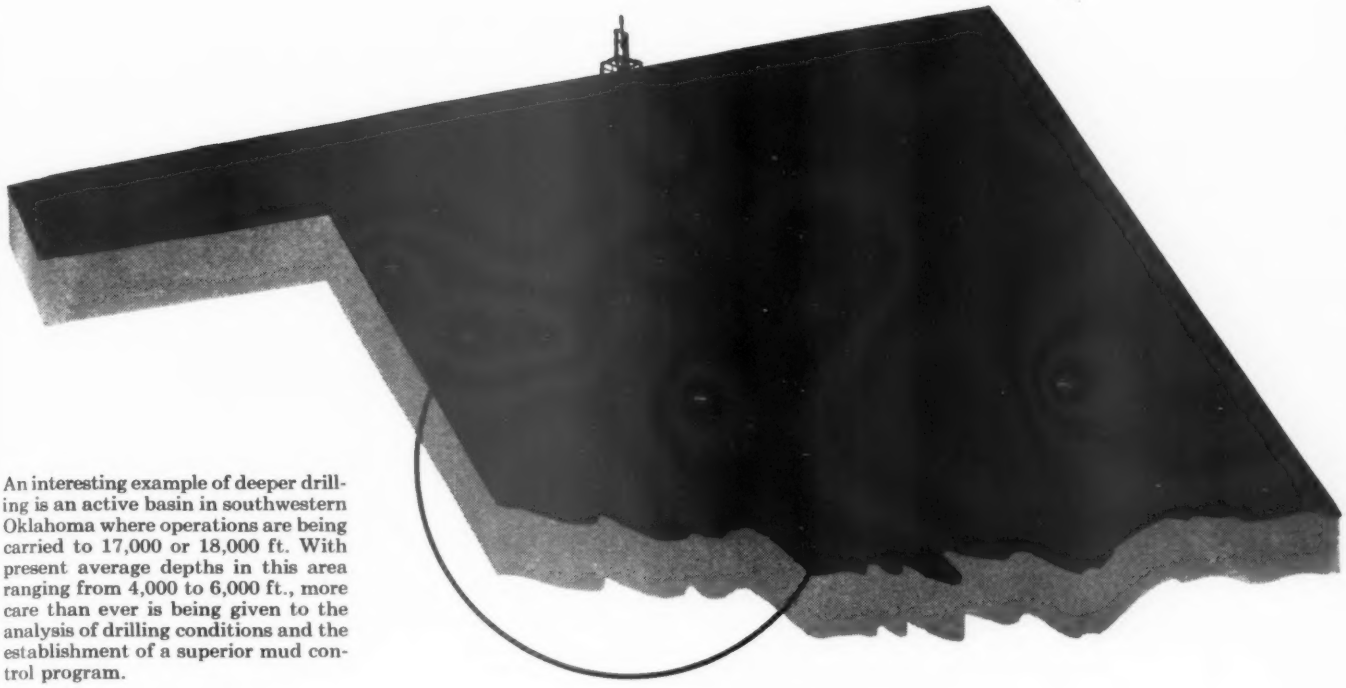
Definition: A portion of a field or area that is at least in part separated from other portions of the field by barriers to migration of oil.

Examples: Wilmington Blocks, Seal Beach Blocks.

● **Discussion.** The pool is the fundamental unit of this scheme of classification. There may be more than one pool in an area or field. The name may be the same or different from the name of the zone, sand, or formation that contains the pool. The pool usually fills only a part of the reservoir in which it is found and there may be a number of other pools in the reservoir, as may be shown by the influence of withdrawal from one pool on performance of the other pool through pressure connection across a water-filled saddle.

It should be particularly stressed that pool differs from zone, sand, formation, and interval in that it is the oil, not the container.

Pools are usually and preferably named from the wells that discover them, that is, the lease name or well number. There is an established antipathy toward use of an operator's name. Pools are sometimes named from the zone or formation in which they are found, but past experience has shown this leads to confusion and should be avoided. Names derived from electric log markers are less troublesome except where separate pools



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Schedule of California Field and Pool Names

(Old usage shown in brackets)

SAN JOAQUIN VALLEY REGION

ANT HILL
- Olcese
- Jewett

BELRIDGE NORTH
- Shallow
- Temblor
- "R-Sand"
- Belridge 64 [Wagon Wheel]
- "Y-Sand"

BELRIDGE SOUTH
- Shallow [South Belridge area]

BUENA VISTA
- Buena Vista Front
- Buena Vista Hills
  - 27-B
  - Others

CANAL
- Stevens

COALINGA GROUP
- *Eastside* [Coalinga East—main area]
  - Temblor
- *Oil City* [Coalinga East—main area]
  - Cretaceous
- *Coalinga Nose*
  - Eocene
- *Coalinga Northeast*
  - Eocene
- *Pleasant Valley*
  - Eocene
- *Jacalitos* [other fields]
  - Temblor
    - Upper
    - Lower
- *Westside* [Coalinga West—main]
  - Temblor

COLES LEVEE NORTH
- Northwest area
- Richfield Western Area
  - 21-1
  - Western-29
  - Main Western

COLES LEVEE SOUTH
- Stevens
  - Condensate-debutanized
  - Black oil

EDISON
- West area [Section 21 area]
  - Second Duff [was in main area—2 Duff]
- Main area
  - First Duff
  - Second Duff
  - Fractured Schist
- Portals—Fairfax area
  - Wicker [was in main—2nd Duff and Fairfax area—Wicker]

ELK HILLS
- Main area
  - Upper
  - Lower
- Northwest area
  - Olig

FRUITVALE
- Martin-Kernco

GREELEY
- Greeley
- 11-2

HELM
- Temblor
  - Upper
  - Lower
- Eocene

KERN FRONT
- All pools

KERN RIVER
- All pools

KETTLEMAN NORTH DOME
- Temblor
- Vaqueros
- Eocene

LANARE
- Miocene
- Eocene

LOST HILLS
- Main
- Williamson

McKITTRICK GROUP
- *Cymric*
  - Shallow
  - 54-21
  - Fitzgerald
  - Anderson
  - Weston
  - Weston 3
  - Bolton
  - Oceanic
  - Woody
- *McKittrick*
- *McKittrick Front*
  - Upper
  - Lower
- *Salt Creek*
  - Salt Creek
  - Carneros

SAN JOAQUIN VALLEY REGION (Continued)

- *Sheep Springs*
  - Carneros
- *Temblor Ranch*

MIDWAY-SUNSET FIELD
- Midway East area
  - Shallow [Midway East]
  - Lakeview
  - Gibson
  - Maricopa Flat
- Midway West area
  - Upper [Midway West]
  - Quality
  - Republic
  - Section 6
- Santiago area
  - Shallow
  - Leutholtz

MOUNT POSO GROUP
- *Baker*
- *Corral Canyon* [Vedder]
- *Dominion*
- *Dorsey*
- *Granite Canyon* [Sunset]
- *Mount Poso*
  - Main area
- *Mount Poso North* [North Mount Poso]

MOUNTAIN VIEW
- Northwest area
- Southwest area
- Earl Fruit area
- Arvin area [includes Others Arvin]

PALOMA
- Paloma
  - Condensate
    - Raw
    - Debutanized
  - Black oil
- Symons
  - Condensate
    - Raw
  - Black oil

POSO CREEK GROUP
- *Enas* [was in *Premier*]
- *McVan*
- *Premier*
- *Premier East*
- *Premier West*

RACE TRACK HILL
- Jewett
- Pyramid Hills—Vedder

RAISIN CITY
- Miocene
- Eocene

RIO BRAVO
- Rio Bravo—Vedder

RIVERDALE
- Miocene
- Eocene

ROUND MOUNTAIN GROUP
- *Coffee Canyon*
- *Round Mountain*
  - Jewett—main
  - Vedder—main
  - Vedder—Northwest
- *Pyramid*
  - Vedder
- *Sharktooth North* [was North Sharktooth]
  - Vedder
- *Sharktooth South* [was West area]
  - Vedder

STRAND
- Stevens
  - Upper
  - Lower

STRAND EAST
- Stevens

TEN SECTION
- Stevens

WASCO
- Shale
- Vedder

WHEELER RIDGE

WILLIAMS [Antelope Hills]
- East Block
- West Block

OTHER FIELDS
- *Antelope Plains*
- *Bellevue*
  - Upper Stevens
- *Belridge Middle* [Middle Belridge area—Shallow]
- *Blackwell's Corner*
- *Burrel*
  - Miocene
- *Canfield Ranch*
- *Chico Martinez*
- *Devil's Den*
- *Gosford*
  - Stevens
- *Jasmin*
- *McClung*
- *McDonald Anticline*
- *Pyramid Hills*
- *Rosedale Ranch*
- *Tejhon Ranch*
  - Metzenbaum

SAN JOAQUIN VALLEY REGION (Continued)

- Reserve (Grapevine)
- Richfield
- *Union Avenue*
- *Vallecitos*
  - Cretaceous

COASTAL REGION

SANTA MARIA DISTRICT
- *Bradley Canyon*
  - Sisquoc
  - Monterey [was Miocene]
- *Casmalia*
  - Sisquoc—Monterey [all pools]
  - Arellanes
- *Cat Canyon East*
- *Cat Canyon West*
  - Pliocene [Cat Canyon—West]
  - Los Flores [Cat Canyon]
- *Gato Ridge*
- *Lompoc*
- *Orcutt*
- *Santa Maria Valley*
  - All Areas
- *Zaca Creek*

SANTA BARBARA DIST.
- *Capitan*
  - Vaqueros
  - Erburu
  - Covarrubias
  - Coldwater
- *Elwood*
  - Vaqueros
  - Sespe
- *Santa Barbara*
  - Vaqueros
- *Summerland*
  - All pools

VENTURA DISTRICT
- *Padre Canyon*
  - Main area
  - Oak Grove area
- *Rincon*
  - Hobson-Tomson-Miley
  - C-9 [Deep]
- *San Miguelito*
  - Grubb One
  - Grubb Two
- *Ventura Avenue*
  - Shallow Pools
    - A-3, B-3
    - B-1, 2
    - B-4, 5 West
    - "C" Block
    - C-1, 2 West
    - C-3 West
    - C-6 West
  - Deep Pools
    - D-3
    - D-4
    - D-5, 6 East
    - D-5 West
    - D-6 West
    - D-7

NORTH SANTA CLARA VALLEY DISTRICT
- *Del Valle*
  - East area
    - Sherman
    - Del Valle
    - DL4-DL5
    - Bering
  - West area
    - Sepulveda
    - Vasquez 13
    - Vasquez-Videgain
    - Sterry
  - Ramona Area
    - Black
    - Ramona
- *Ex-Mission Group*
- *Hasley Canyon*
- *Holser Canyon*
- *Hopper Canyon*
- *Modelo*
- *Oak Canyon*
  - 1-A
  - 3-AB
  - 4-AB
  - 5-A
  - 8-AB
- *Sespe Canyon Group*
- *Sisar-Silverthread*
- *Sulphur Mountain*
- *Temescal*
- *Timber Canyon*
- *Tiptop-Fresno Canyon* [Ventura-Ojai]
- *Topa-Topa*

SOUTH SANTA CLARA VALLEY DISTRICT
- *Aliso Canyon* (was in L. A. Basin)
  - Porter
  - Sesnon
  - Faulted Sesnon
  - Eocene

COASTAL REGION (Continued)

- *Bardsdale*
  - Elkins area
  - Other areas
- *Newhall*
- *Newhall-Potrero*
  - 1-2-3
  - 5th
  - 6th
- *Oat Mountain*
- *Oxnard*
- *Shiells Canyon*
- *Simi*
- *South Mountain*
- *Tapo-Eureka*
- *Torrey Canyon*
- *Wiley-Towsley Canyon*

OTHER DISTRICTS
- *San Luis Obispo County*
  - *Edna*
  - *Pismo*
    - Martin
    - East Elberta
- *Santa Clara County*
  - *Sargent*

LOS ANGELES REGION

ALONDRA

BREA-OLINDA
- Brea area
- Olinda area
- Tonner area

COYOTE EAST
- Graham-Loftus-Hualde
- Mathis
- Stern

COYOTE WEST
- Murphy
- Ninety-nine
- Lower Ninety-nine East
- Emery East
- Emery West
- McNally

DOMINGUEZ
- Pliocene
  - East Block
    - 3rd, 4th and Upper 5th
    - Lower 5th and 6th
  - West Block
    - 5th West
  - Other Blocks [Pliocene—Others]
- Miocene
  - 7th Central Block
  - 8th Central Block
  - South Central Block
  - Southwest Block
  - West Block
  - West Town Lot Block

EAST DOMINGUEZ

EAST LOS ANGELES

EL SEGUNDO
- West area
- Other areas

HUNTINGTON BEACH
- New area
  - Tar Zone [On-Shore—Tar Zone]
  - Jones
    - A-37
    - A-66
  - On-Shore Main
  - Off-Shore Main
- Old area
  - Tar Bolsa
  - Ashton

HYPERION

INGLEWOOD
- Vickers-Machado
- Rindge
- Rubel
- Moynier
- Sentous

LONG BEACH
- Old area
  - Upper Pools
  - De Soto
- Northwest Extension area

MONTEBELLO
- Main area
  - Baldwin One-Two-Three
- East area
  - Cruz
  - Nutt
- West area
  - All pools [Includes Fifth Zone, Sixth Zone, Masser Zone, Seventh Zone, Eighth Zone, Ninth Zone]

NEWPORT FIELD
- Newport Beach area
- West Newport Beach area
- Aldridge area
  - "B" Pool
  - "C" Pool
- Anaheim Sugar area

PLAYA DEL REY
- Del Rey Hills area

LOS ANGELES REGION (Continued)

- Venice area

POTRERO
- Central area
- East area
  - Potrero No. 2
  - Other pools
- West area

RICHFIELD
- East
- West

ROSECRANS-ATHENS GROUP
- *Rosecrans*
  - Maxwell-Hoge
  - Zins
  - Miocene
    - O'Dea [Miocene - Seventh]
    - Eighth
    - Bank-Miocene 7 and 8
- *Athens*
  - Upper
  - Lower
  - O'Dea [Miocene]

SANTA FE SPRINGS
- All pools

SEAL BEACH
- Alamitos area—South of Fault [was Alamitos Heights]
- All pools
- North Block
  - San Gabriel
  - Selover
  - Wasem
  - McGrath
- South Block
  - Bixby-Selover
  - Wasem
  - McGrath

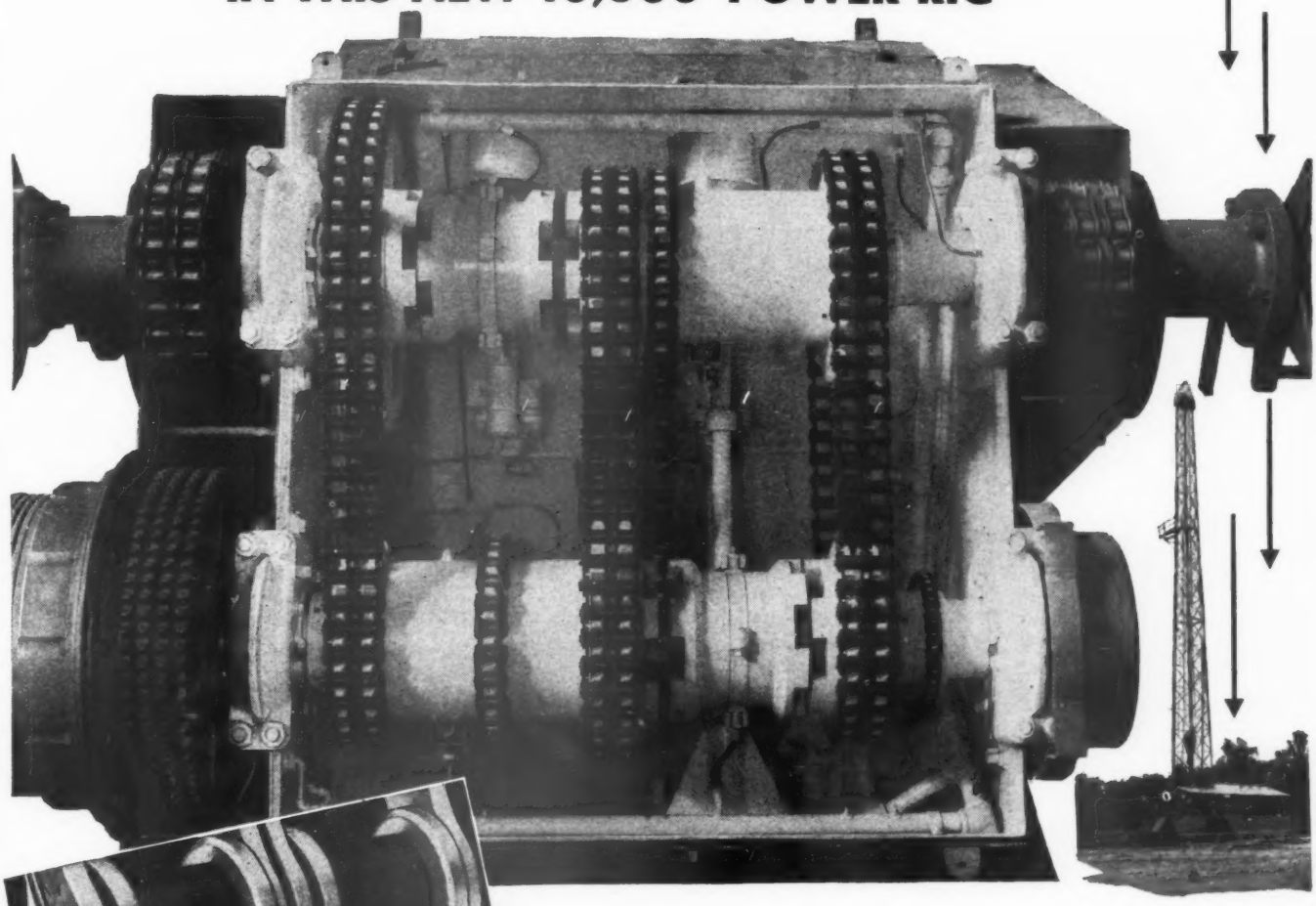
TORRANCE
- Hermosa area
- Torrance area
  - Main [includes Torrance Extension]
  - Thirty-four
  - D. and B.
  - Vesta

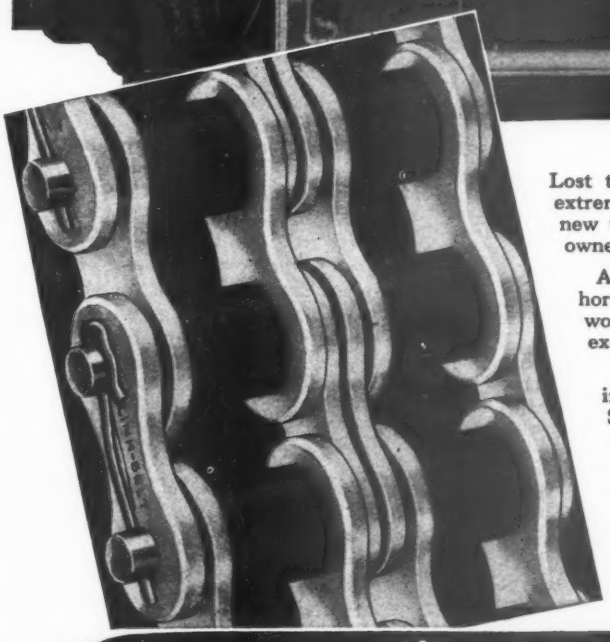
WHITTIER
- Central
- La Habra
- Rideout-Heights

WILMINGTON
- Terminal area
  - Fault Block I
    - Tar-Ranger-Terminal
    - Ford
    - 237
  - Fault Block II
    - Tar-Ranger
    - Terminal U and L
    - U. P.
    - Ford
    - 237
  - Fault Block III
    - Tar-Ranger
    - Upper Terminal
    - Lower Terminal
    - U. P.
- Harbor area
  - Fault Block IV
    - Tar
    - Terminal U and L
    - U. P.
    - Ford
    - 237
  - Fault Block IV and V
    - Ranger
  - Fault Block V-A
    - Terminal U and L
  - Fault Block V-B
    - Upper Terminal
    - Lower Terminal
- Town Lot area
  - Tar-Ranger-Terminal
  - Ford

OTHER FIELDS
- *Buena Park*
  - East
  - West
- *Kraemer*
- *La Mirada*
- *Lawndale*
- *Leffingwell*
- *Los Angeles Group*
  - *Beverly Hills*
  - *Los Angeles*
  - *Salt Lake*
- *North Whittier Heights* [was Turnbull Capital Co.]
- *Puente Hills*
- *Sansinena*
- *Turnbull* [take out Capital Co.]
- *Western Avenue*
- *Yorba Linda*
  - Shell
  - Smith

BREWSTER EMPHASIZED PORTABILITY, COMPACTNESS AND LINK-BELT *Silverlink* IN THIS NEW 10,000' POWER RIG





Lost time in moving and rigging up has been greatly reduced with the extremely portable and compact Brewster N-10 Power Rig. First of these new units built . . . a combination of ideas of the manufacturer and rig owners . . . is being operated by Crow Drilling Co.

A strong sectionalized, "quick assembly" derrick which is assembled horizontally on the ground and raised into position . . . a unitized drawworks and transmission . . . an enclosed, compact sub-structure are exclusive features of the new Brewster Rig.

They have eliminated lost time from chain troubles, too, in this initial 10,000' power rig. It's equipped throughout with Link-Belt Silverlink. Input drive to transmission from engine compounds is chained with Link-Belt 1¼" pitch quad. Transmission drives are 2" pitch double and 2" pitch single for rotary. High and low drum drives are 2½" pitch double. Compounds are 1¼" pitch triple width Link-Belt chain.

Link-Belt Silverlink has been the choice of rig owners and manufacturers alike for years. It's the result of more than 70 years of continuous chain improvements.

LINK-BELT COMPANY

Indianapolis 6, Dallas 1, Houston 2,
Los Angeles 33, Kansas City 6, Mo.,
New York 7, Toronto 8. 10,492

LINK-BELT *Silverlink* **ROLLER CHAINS**

E-Z ASSEMBLY

Link-Belt Engineers have developed a construction that makes assembly and disassembly of multiple width chains in the field much easier. The press fits between chain pins and center sidebars have been eliminated, but load distribution across the width of the chain has been maintained.

exist in different areas of fields but between the same markers. In the future, the committee will prefer the lease or well number as the source of pool name and will endeavor to avoid use of formation or zone names, particularly if confusion may arise.

The term area is used in many ways in the oil industry but as applied to producing territory it is best confined to the use indicated in the definition. Thus even a single producing well constitutes an oil field if it is isolated. Areas are named preferably from geographic features but if such a feature is lacking may be named from lease, or some other descriptive term. Operator's name should be avoided and compass direction used only as last resort.

A field may consist of more than one area. Some older fields such as Edison have widely spaced areas, which under the present standards would be considered separate fields. The new listing does not make a change in this as statistics and usage are established but in future work discoveries separated by considerable distances from previous production will be regarded as new oil fields unless there is good possibility that the gaps will be closed by development. Fields should be named from a geographic feature, preferably one that is shown on published maps. As second choice a well known feature not on published maps is acceptable. The name of the operator is not acceptable. Names of individuals are acceptable only if they are so well established that they have become essentially a geographic name like MacDonald, Leffingwell, or Rosecrans. Clarity and convenience, however, take precedence over a slavish adherence to rules.

A term group is introduced as a convenient means of listing closely associated oil fields. This is desirable in some cases where production figures are not available for the fields separately. Other groupings have been made and still others are possible. Those made by the joint committees are believed to be best for the purpose. The principle to be followed is that the group shall be a logical geographical unit that will indicate at a glance the fields that comprise the group.

District is another term of various prior usages but as here defined permits cataloging of production statistics in natural and logical geographical units so that data can be more readily found and compared.

Region is a term for the large sections of oil territory like the L. A. Basin and San Joaquin Valley. The adoption of this term was necessary as district is to be used only for portions of a region. The district and region boundaries are chosen so that there is little or no chance for a field to extend across them. The Northern Region, as defined by the committee, consists of the coast north of San Francisco, the Sacramento Valley and the San Joaquin Valley north of Merced County.

It is not the purpose of the committee to name zones, formations, or reservoirs except incidentally where a new pool discovery may also be a new zone discovery and the same name may be appropriate for both.

Past experience has shown unsuitable names may become so firmly attached to a wildcat play in the prospect stage that change is difficult when discovery is made. The committee feels that it is desirable to find appropriate names before discovery; therefore, to help establish this system the committee will endeavor to provide such names for any active exploratory project if requested by operator, scouting organization, news service, or other interested persons. In this way less confusion will develop if discovery is made and more systematic listing of active wildcats will result.

Operators and others interested in field or pool names are invited to consult the Classification Committee members on such problems. The members and addresses are as follows:

Frank B. Carter, General Petroleum Corporation, Higgins Building, Los Angeles 12, California.

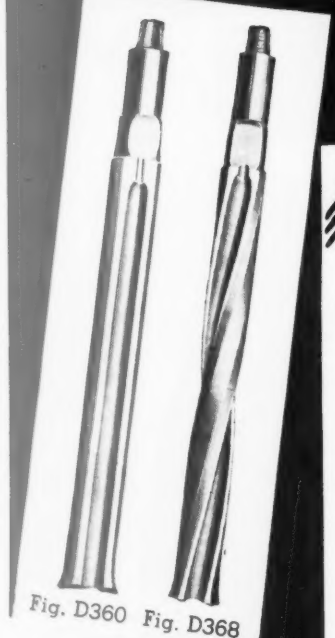
R. D. Patterson, Shell Oil Company, Inc., Bakersfield, California.

Harvey W. Lee, Union Oil Company, 617 West 7th Street, Los Angeles 14, California.

Graham Moody, Standard Oil Company of California, Standard Oil Building, San Francisco 20, California.

Frank S. Parker, Chairman, Signal Oil and Gas Company, 811 West 7th Street, Los Angeles 14, California. ★★★

FOR THE BEST IN CABLE TOOLS



SPANG HEAT-TREATED DRILLING BITS

Spang Drilling Bits are forged by a patented process which assures a sound, homogeneous product. The steel is made to specifications, which have been developed out of a long experience, to give the maximum of footage per dressing.

In the heating and forging operations, the most modern methods are used. Each step is carefully planned and executed to produce sound forgings. Heat treatment by use of modern furnaces with heat-recording instruments and experienced personnel insures the maximum of joint strength. A field dressing instruction chart is yours for the asking.

Spang Drilling Bits reflect the skill and knowledge that make every Spang Cable Tool a "Higher Standard" product.

THE HIGHER STANDARD

SPANG & CO.
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YOUR DEALER SELLS SPANG TOOLS

new and improved machinery and equipment

A REGULAR FEATURE
appearing in
THE *Petroleum* **Engineer**
Irwin-Keasler Building
Dallas 1, Texas

NEW EQUIPMENT

(1) Ajax gas engines

Completion of the first modern gas engine bearing the Ajax nameplate has been announced by Ajax Iron Works, Cory, Pennsylvania, signalizing the progress made in the company's greatly-expanded manufacturing program to produce Ajax gas engines built on the famous Superior pattern, formerly built by the Superior Engine Division of National Supply Company.

Since the sale of Superior gas engine manufacturing rights, tools, jigs, and fixtures to Ajax Iron Works a year ago, the Ajax organization has increased its plant facilities by more than 50 per cent, including, despite construction difficulties, a large new addition to the foundry and new shops, assembly and warehouse buildings for Ajax gas engine production.

An ample supply of parts for the thousands of Superior gas engines now in service will be maintained, it is stressed by Ajax, assuring operators of complete parts service.

A major distributor in the oil country will be National Supply Company, which, with its scores of stores and hundreds of representatives in the field, will actively promote Ajax gas engine sales.

Export market demands will be met by the production of Ajax gas engines in all popular sizes, in accordance with the increasing trend abroad to these slow-speed, heavy-duty units, whose portability, simplicity, and reliability are outstanding under the hardest use and in the most isolated locations.

(2) Oxyarc cutting process

Arcos Corporation has developed a new method for hand cutting or piercing stainless and stainless clad, alloy steel, aluminum, bronzes and brasses, cast iron, Monel Inconel, and nickel. The process—known as the Arcos Oxyarc Process—achieves the cutting by the combination of an electric arc and a stream of oxygen.

The equipment consists of a specially designed Arcos Oxyarc holder, and a tubular coated Oxycuttend rod that is consumed in the process of cutting. The process can be used wherever an a-c. or d-c. welder and bottled oxygen are available. The "knack" of cutting with Oxycuttend can be acquired in less than an hour's time.

Because the Oxyarc Process will cut or pierce any metal, in any shape, and in any position, it can be used to great advantage in a wide variety of metal cutting operations.

(3) Portable leak detector

A new portable leak detector that can locate and measure leaks in vacuum and pressure systems as minute as 0.00000001 cc per sec. is now being manufactured by the Consolidated Engineering Corporation of Pasadena, California. Based on the mass spectrometer principle, this instrument electronically separates and measures helium molecules, by reason, only, of their mass, from all dissimilar molecules in the atmosphere. Introduction of helium in suspected areas will give an almost immediate indication on the visual meter or audio alarm system whenever any leakage is present.

Even an inexperienced person can operate this leak detector, for only a few connections place the instrument in the system and a few adjustments prepare it for use. Selection of sensitivity over six different ranges can be had for measuring almost any rate of leakage. Size of the leak can also be determined with the audio system when using a helium probe at a distance from the instrument. The pitch of the leakage warning signal changes roughly in proportion to the leak size.

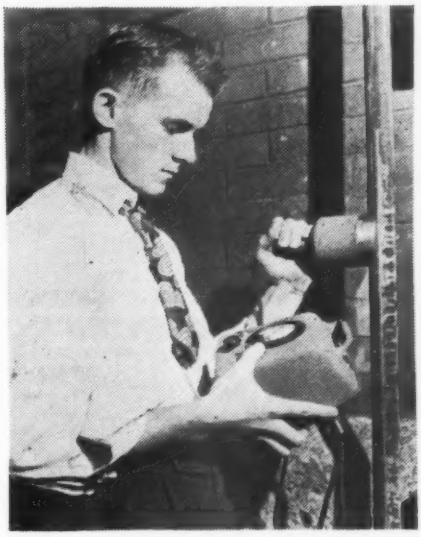
The instrument is completely portable, being installed in a cabinet 43 in. high, 25 in. deep, and 22 in. wide and mounted on ball-bearing rubber tired casters. Electrical chassis are mounted on the back of the door, which has a removable panel to permit entrance to the wiring of the chassis. Standard readily available electrical and vacuum system components are used. The equipment is operated entirely from a standard 115-volt, 60-cycle lighting circuit.

(4) G-E pipe gage

A new thickness gage designed to measure the thickness of iron or steel pipes from the outside has been announced by the Special Products Division of the General Electric Company. Called a pipe thickness gage, Type MS-A, the new instrument can be used on pipes up to ¼ in. in thickness and from 1 to 2 in. in diam. Applications include checking the safety factor of pipes and tubing carrying petroleum products, chemicals, steam, or gas.

The new thickness gage consists of an indicating instrument, a gage head, and a saddle that is connected to the gage head by two screws. A different saddle is re-

Using gage to check pipe thickness.



quired for each diameter of pipe. To operate, the saddle is placed upon the pipe, and thickness is indicated in fractions of an inch on the indicating instrument.

The gage measures the average thickness of a pipe over an area of several square inches. Accuracy of plus or minus 1/64 in. can be obtained on clean surfaces, and 1/32 in. on dirty surfaces. Dirt, scale, and paint on the inside of a pipe do not add to the thickness reading. The gage head and saddle combination weighs about 6½ lb. The instrument operates on 115-volt, 60-cycle power.

(5) "Transet" system

"Transet" is the name given by Taylor Instrument Companies to a new pneumatic transmission system particularly adapted to applications involving long lead lines between transmitter and control panel, and where compactness of control panel is a consideration. It is applicable to the control of temperature pressure, rate of flow and liquid level.

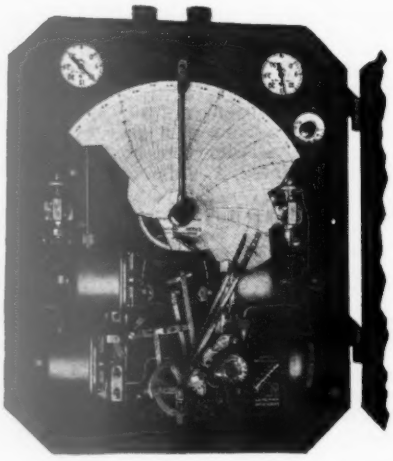
The Transet controller regulates the control valve and also transmits air pressure, proportional to the pen movement, to the indicating receiver remotely located on a panel board. The left-hand gauge of the receiver unit is calibrated in the same units of measurement as the controller chart, thus providing an indication of the controlled variable. The right-hand gauge of the receiver gives an indication of the set pointer position. Thus when both pointers of the receiver unit coincide, the pen and set pointer of the Transet controller will be together and the process will be under control.

The controller set pointer is pneumatically adjusted by manipulating the reducing valve on the right end of the receiver panel until pointer of pneumatic set gauge is at the desired value.

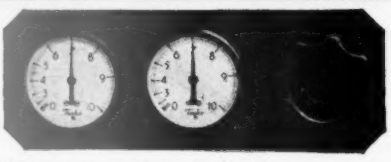
Precise control is achieved by eliminating, or reducing to a minimum, the time lag in the control circuit, because the controller may be situated adjacent to the point of measurement.

The Transet receiver is so compact that seven of them take up no more space than two conventional recording receiver-controllers. This means greater economy especially on large installations, and greater convenience for the process engineer who can quickly check all related process variables without having to move all over a large control room, it is asserted.

Extremely compact, the standard Taylor case contains not only the "Transet" controller, transmitter and pneumatic set mechanisms, but also allows ample space for either a spring-driven or explosion-proof electric chart clock.



"Transet" recording controller-transmitter.



"Transet" receiver. Indicating receiver (left), set pointer (center), set point adjustment (right).

(6) Small hydraulic couplings

A new series of small hydraulic couplings for use with induction motors and small internal-combustion engines has been announced by the Twin Disc Clutch Company.

The six couplings in the new series have various ratings, ranging from one to 25 hp. at 1800 rpm. They supplement the widely used line of Twin Disc hydraulic couplings for larger applications.

Experimental models of the new series of couplings, used during the last year in all types of jobs in the one to 25-hp. range, have brought reports of extremely satisfactory results.

The six small couplings not only are on the market but already have been adopted as standard for a variety of applications in the recently announced "Electrofluid Drive," a packaged power unit sold by the Link-Belt Company. The "Electrofluid Drive" consists of an electric motor and a Twin Disc hydraulic coupling enclosed as a single unit, available in horsepowers up to 20.

Roger DeLong, sales manager, Hydraulic Division, Twin Disc Clutch Company, Rockford, Illinois, points out the following advantages to be gained by using hydraulic couplings with induction motors and small internal-combustion engines:

They assure smooth acceleration, prevent stalling, allow the engine or motor to be fitted to actual running requirements, eliminate the need for shear pins and similar "break-and-replace" protection for driven parts, distribute the load on multiple engine or motor drives, permit the reversing of electric motors at full-load speed without high current surges, and, in case of a standard motor, permit the motor to start under no load and thus makes high torque available for starting.

"Twin Disc small hydraulic couplings have been specifically designed to produce the ultimate in performance so that these advantages may be gained in actual operation," DeLong said. "The small coupling series will be used in innumerable applications wherever induction motors are concerned—not to mention the many applications on small gasoline engines which could well take advantage of the couplings' characteristics.

"The Twin Disc line of hydraulic couplings, including the small coupling series, represents the farthest engineering advance in the fight to make internal-combustion engines and electric motors more flexible in operation and outstanding in performance. These hydraulic couplings, large and small, eliminate the solid connection between the power sources and the driven equipment."

All but the smallest of this new line of hydraulic couplings retain in their design the customary Twin Disc double circuit, which consists of two sets of blades on both the driving and driven members of the coupling. This design permits the greatest horsepower capacity per inch of coupling diameter and, at the same time, produces a hydraulically balanced unit.

A simple form of design has made the coupling a very compact unit and one which will not present difficulty in installation, according to DeLong.

Both the impeller, or driving member, and the runner, or driven member, are lightweight aluminum castings. A cast-iron insert forms the hub of the driven member, taking the drive to the output shaft. Stamped steel core rings in both the impeller and the runner form the hydraulic circuit.

The unit is assembled by installing the runners and then merely screwing together the impellers with a rubber or coprene ring gasket to insure against leakage.

(7) Lincoln a-c. welder

The Lincoln Electric Company, Cleveland, Ohio, announces the new "Fleet-Arc" a-c. welder, which is said to have many features not possessed by conventional a-c. welding units.

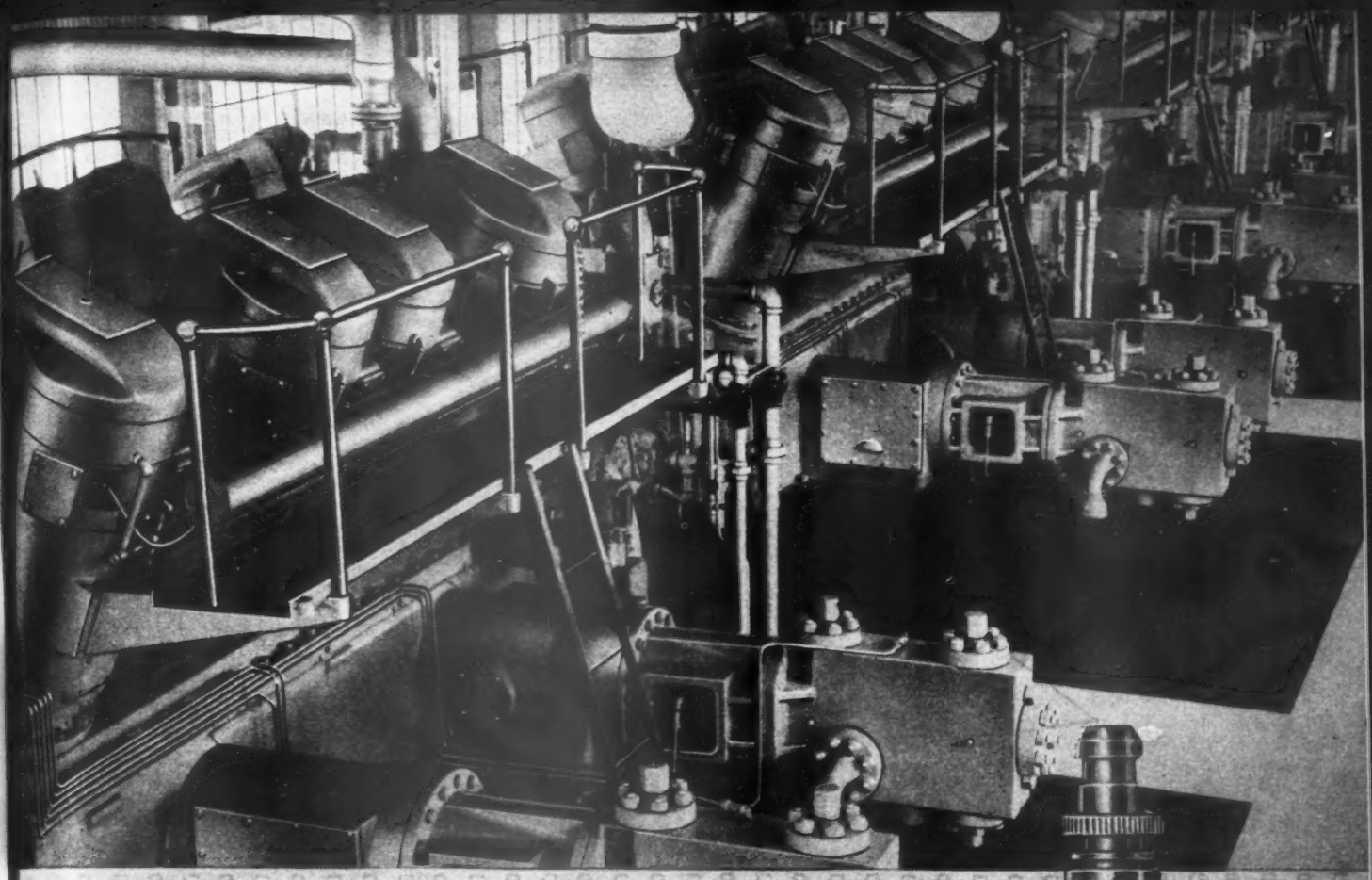
The new "Fleet-Arc" a-c. welder, equipped with the "Arc Booster," surpasses the conventional a-c. welders in ease of welding, depth of penetration, range of output, economy of operation, safety, dependability, and service life, it is stated.

The "Arc Booster" augments the current the instant the arc is struck. The arc is started automatically the moment the electrode touches the work. This added feature of the new welder has been accomplished safely without the use of special high frequency devices or higher voltage.

A selector switch on the front of the welder governs the amount of booster current to be used in striking the arc. This provides a complete range of striking intensity to suit requirements in the welding of thin sheets or heavy plates, making of tack welds, or in the use of various types and sizes of electrodes.

The "Arc Booster" enables the operator to achieve the maximum depth of penetration in every job, and has the added facility of attaining the maximum depth at the beginning of the weld, it is asserted.

Current control, continuous and self-adjusting, is provided by the rotating reactor



Continuous, Dependable Ignition

NINE INGERSOLL-RAND (Type 8KVG) gas engine driven compressors in use at the world's largest cycling plant, the "group-owned" Katy Plant, Katy, Texas.

THE 72 CYLINDERS OF THE ENGINES driving these compressors develop 7,200 H.P. *and rely on 72 BG SPARK PLUGS for continuous, dependable ignition.*

ARMY NAVY

For complete information write **DEP'T E**

THE BG CORPORATION

136 WEST 52nd STREET, *New York 19, N. Y.*

control, which affords fast setting throughout the exceptionally wide range of the welder. The operation of current control is fast and involves the simple act of turning a hand wheel, which requires a minimum number of turns to cover the range. The amperage is indicated on a calibrated dial on the face of the welder, placed in a weatherproof and readily visible position on the face of the unit.

The reactor current control, held in position by cone brakes and actuated by a self-cleaning chain drive, is smooth running and durable.

Arc characteristics of the new "Fleet-Arc" a-c. welder are excellent, with a new type reactor control designed for high responsiveness to changing arc conditions.

Separate power transformer and adjustable reactor control enable the "Fleet Arc" a-c. welder to duplicate the wide range of output of d-c. welders, and at the same time simplifies the low current welding of thin sheets and increases the welding of heavy plates at high current value.

Thermostatic control, which opens the magnetic starter when overloaded provides a high degree of self-protection for the operator, permitting sustained welding at high current values and use under abnormal conditions with complete protection against damages resulting from overheating.

A higher power factor and a reduction of condenser requirements and less shock to the operator has been gained through the use of the "Fleet-Arc's" lower open-circuit voltage. In reducing the amount of condensers required in comparison to the usual a-c. welders, the idle input current has been decreased considerably.

The "Fleet-Arc" a-c. welder, manufactured in 200, 300, and 500 amperage range, has both frame and housing of all-welded construction to assure maximum strength and durability.

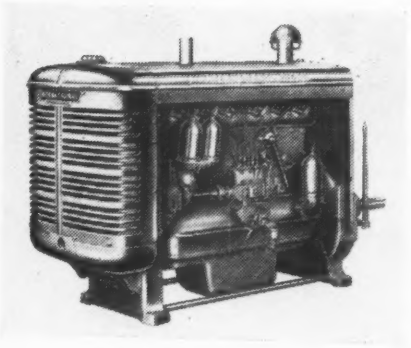
(8) Diesel power units

Start of production on a 125-hp Model UD-18A power unit and a 76-hp. Model UD-14A is announced by H. T. Reishus, general manager of International Harvester's industrial power division, and Neal Higgins, manager of sales. Both power units are heavy-duty four-cycle diesels with the same bore and stroke. The UD-18A has six 4¾-in. by 6½-in. cylinders, and the UD-14A has four. Both units are assembled at International Harvester's Melrose Park Works.

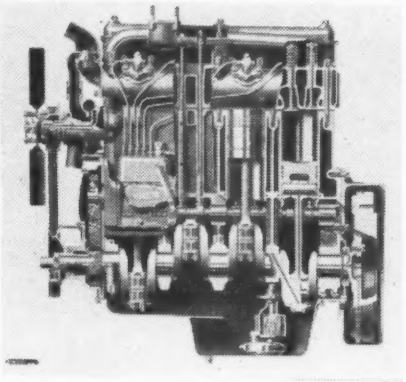
The UD-18A and UD-14A deliver in full measure considerably more power without increase in weight over the popular UD-18 and UD-14 models that they displace. A new cylinder head arrangement, improved nozzles, and redesigned precombustion chambers give them higher compression and greater efficiency in converting fuel energy into low-cost power. Since the International diesel starting system does not require preheating of the incoming air even in cold weather, it has been practical to place the exhaust manifold on the injection side of the engine, away from the intake manifold. As a result, incoming air is kept cooler. Volumetric efficiency or "breathing" ability, is greatly increased resulting in more lugging ability and greater power output with clean combustion.

Both the UD-14A and UD-18A power units achieve their higher rpm and increased horsepower without resort to special lubricating oils. Ordinary lubricating oil of good quality is satisfactory for these engines because of excellent cooling and combustion characteristics. An oil control ring of a new type assures satisfactory cylinder lubrication without excessive oil consumption.

International's integral gasoline starting



UD-18A diesel power unit.



Sectional view UD-14A engine.

system has been retained in the UD-14A and UD-18A diesels. The engines are started on gasoline in the same manner as an ordinary gasoline engine. After a brief direct-flame cylinder warm-up, movement of a single lever changes the engine from the gasoline starting cycle to four-cycle diesel operation with compression ignition.

The UD-14A and UD-18A are available for many different kinds of jobs in a variety of equipment combinations from engines to complete power units ready for operation. With one or more power unit components added, these diesel engines are also being delivered to many manufacturers of industrial equipment. New machines built by these manufacturers and utilizing the increased horsepower of these diesel engines will soon make their appearance.

(9) Centering pilot

The centering pilot developed by the Landis Machine Company, Waynesboro, Pennsylvania, is designed for its 8⅝-in. and 13⅜-in. receding chaser pipe threading and cutting off machines.

The spring pilot is bolted onto the rear of the cross rail. As this necessitates the removal of the cutting off slides, the machine is limited to threading only when equipped with the spring pilot.

As the spring pilot forms a center in the bore of the die head for centering the pipe with the die head, only the rear chuck of the machine is used to grip the pipe during the threading operation. It is necessary that the front chuck clear the pipe by approximately ⅛ in. to permit the pilot to fully engage the bore of the pipe.

In operation, the pilot is forced forward by a spring and engages the bore of the pipe prior to the pipe advancing to the chasers. The spring forces at the rear of the pilot are taken up by an anti-friction bearing. The 10-deg. angle of the pilot permits its use on different wall thickness of pipe. When the pilot is changed for different diameter of pipe it is only necessary to remove one screw in the center of the pilot. The principal advantage of the spring pilot is that it centers the pipe true with the die head assuring concentric threads and permits of higher threading speed. Chatter is eliminated from the thread by the pilot and the chasers can be set farther back of center thus increasing the clearance back of the cutting edge. This setting of the chasers results in greatly increased tool life and materially improved thread finish.

(10) Recording rotameter

The combined engineering staffs of Schutte and Koerting Company and the Foxboro Company have perfected a new type of recording rotameter utilizing the Dynalog* system of transmission by electronic high frequency circuits. The recording system, used on the recording rotameter, is based on the induction bridge system and makes available many new features for rotameter application.

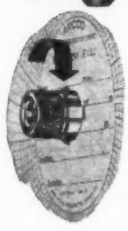
With the new recording rotameter and the Foxboro electronic Dynalog recorder great speed can be obtained. Instantaneous response to change of flow, continuous balance, rugged power, continuous connections, unit construction using four principal assemblies, direct linkage with no gears, positive liner motion, long life, and elimination of over-travel are features of this system.

This induction transmitter is now available for recording the rotor positions of many standard SK rotameter designs, including the SK Universal rotameter, the SK Armored rotameter and others.

*Reg. U.S. Pat. Off., Foxboro Company.

(11) "Speed-Lok" chart hub

The new Arcco-Macnick "Speed-Lok" chart hub saves valuable time in changing charts, the manufacturer states. It fits almost



almost all tapered arbor chart clocks, replacing the old style two-piece hub. The equipment consists of a single unit integral with the clock without loose parts to handle when changing charts, therefore there are no parts to drop, damage or lose.

The chart is placed on the hub, the knurled nut turned to the right, and three hidden fingers appear to lock the chart securely in the desired position without damage to the center hole. A turn to the left of the knurled nut releases the chart. This unusual three-finger locking device is a patented exclusive feature of the Arcco-Macnick "Speed-Lok" chart hub.

(12) Pipe-leak clamp

A new, all-purpose pipe-leak clamp called the Patchmaster is announced by Marman Products Company, Inc., Inglewood, California.

The Patchmaster is designed to stop leaks on low or high pressure pipe ranging in size from ½ in. to 4 in. in diam. It consists of a corrosion-resistant, stainless steel Marman Universal clamp and a specially designed patch plate of stainless steel annealed sheet that naturally forms to pipe contour, and a Hycar oil-resistant pad. When installed and clamp is tightened, pressure is brought against the pipe, positively sealing leak.

Patchmasters have been tested at 800 psi without leaking. They come in four popular sizes to handle all pipe diameters up to 4 in. and can be used over and over without any efficiency loss. One clamp fits any pipe size up to maximum diameter of clamp.

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Continental Motors Corporation

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205 Market St., Muskegon, Michigan
5077 S. Santa Fe, Los Angeles 11, Calif.

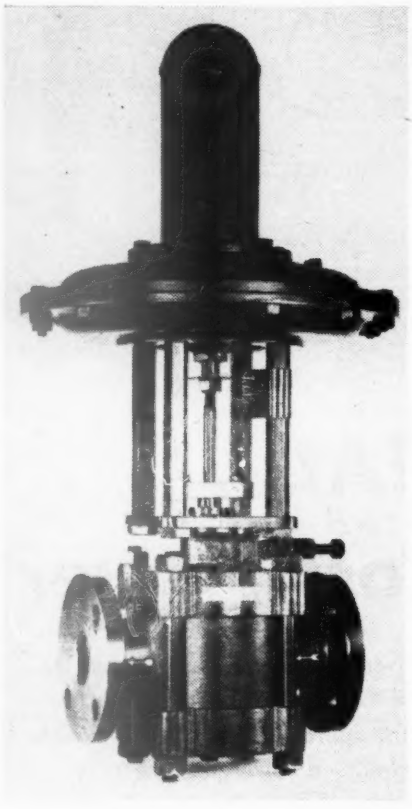
(13) Diaphragm motor valve

A totally new design in diaphragm motor valve construction has been announced by the Fischer and Porter Company of Hatboro, Pennsylvania. These valves are to be known as "The Valvrator Line" and as the name implies, it is an outgrowth of the recording-controlling Flowrator instrument, an area type flow rate meter that heretofore has been the principal product of the Fischer and Porter Company.

Chemical service applications have usually highlighted the Flowrator instrument; so valves suitably constructed for similarly difficult conditions have been a natural outgrowth.

Several unusual design features have been incorporated in the new valve. Outstanding among these is the dished-bonnet construction with flush-seated bodies and through-bolts. No bonnet flanges are included in the body construction, and the design results in a compact unit with the lowest possible weight, greatly simplified cleanout characteristics, and the possibility for fabrication in nearly all corrosion-resisting materials. Body materials such as iron, bronze, stainless steel, carbon steel, hard lead, haveg, hard rubber, monel, nickel, hastelloy, and even porcelain are regularly available.

The valve is made only in 150-lb construction in sizes from ¼ in. to 1 in. screwed, and from 1 in. to 3 in. flanged.



(14) Mobile floodlighter

The new Onan Commercial Floodlighter provides ample, dependable light for night jobs anywhere, or for any application requiring a portable, independent, powerful light source.

Completely self-contained, the new Onan Floodlighter is housed in sturdy sheet metal. It is easily operated by one man and can be hitched to any vehicle and towed safely at high speed.

The floodlighter assembly consists of an Onan 3000-watt a-c. electric plant, plus four powerful floodlights. The 750-watt floodlights are mounted on steel standards that may be raised to a height of 7 ft., and which swing a full 360 deg. horizontally, with a wide vertical arc. Each floodlight is operated by a separate toggle switch. A wide selection of floodlight combinations are available.

The Onan 4-cycle gasoline engine, prime mover for the electric generator, is air-cooled, which means minimum service requirements and dependable performance in any weather. The floodlighter has electric push-button starting, and the generating unit provides a d-c. output for recharging the two heavy-duty starting batteries. Four convenient receptacles are available for operating auxiliary lights or electric tools. Economical to operate, the unit requires only 0.183 gal. per kwhr at full rated load.

(15) Cut-out switch

Centrally located periodic temperature measurements for industrial processing have been made possible by introduction of new recorder cut-out switches that are especially adaptable to the petroleum and chemical industries.

The cut-out switch, developed by the Brown division of Minneapolis-Honeywell Regulator Company, consists of a double-pole, double-throw mechanically operated push-button switch for multi-point indicators. The switch, according to L. Morton Morley, vice president and general sales manager of Brown Instrument Company, Philadelphia, provides cheaper and more practical installations for many critical applications. It does away, he said, with costly additional equipment.

(16) Tube cleaner motors

The new jet motors for tube cleaning, have been announced by the Elliott Company, Roto Division, Newark, New Jersey. The new motors, called the Roto Air Jet and the Roto Water Jet, driven by air and water respectively, were developed after extensive aerodynamic and hydrodynamic research. The Air Jet motor can be adapted to operate with steam.

According to the company's laboratory and field test data, the power developed by the new Roto Air Jet Motor is so much greater than is required or desired for ordinary tube cleaning applications, that commercial models have been throttled down to operate at only a fraction of their potential power. Yet they develop from 100 per cent to more than 250 per cent more power than previous Roto motors, the larger sizes showing the greatest increases. Air consumption per horsepower has been reduced 60 to 80 per cent.

The Roto Air Jet Motor is extremely simple, having only two moving parts, a shaft and a blade. The Rotocentric (egg-shape) bore in the cylinder assures close contact between both opposite edges of the blade and cylinder at all times, permitting minimum air leakage and maximum utilization of air.

The Roto Water Jet Motor, although less powerful than the Roto Air Jet, represents an important advance in water-driven tube cleaners. A radical design change in the turbine wheel and other parts resulted in the production of, what is said to be, the most powerful and economical water-driven tube cleaner ever built. Power has been increased more than 100 per cent and water consumption per horsepower has been reduced 80 per cent on one of the smaller models.

Existing Roto cutter heads and operating hose will fit the new jet motors. Roto Air Jet and Water Jet motors are available for most common tube sizes, and other sizes are being added rapidly.

(17) Chart legibility

Bailey Meter Company, Cleveland, Ohio, has recently introduced recorder charts printed in neutral gray. This makes it easier for operators and supervising engineers to read the charts because of the greater emphasis given the various colored records by the neutral background. The new charts are especially valuable on recorders installed where lighting is poor or where it is impossible to get a clear view of the chart, it is asserted. The improvement in legibility is especially apparent with the dark colored recorder ink normally used, such as red, blue, and green.

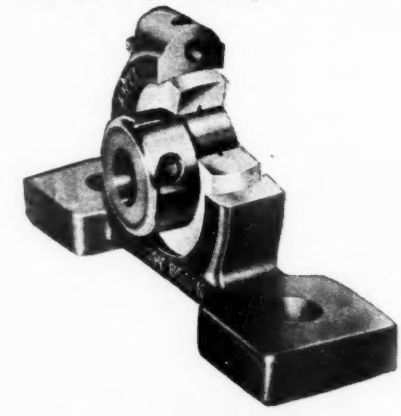
Bailey charts are accurately made from wax engraved plates insuring perfect, correctly spaced, concentric divisions, the manufacturer states. The center holes are punched simultaneously with the printing to insure accurate centering. A special trimming process provides full size charts, at the same time eliminating errors caused by eccentric charts.

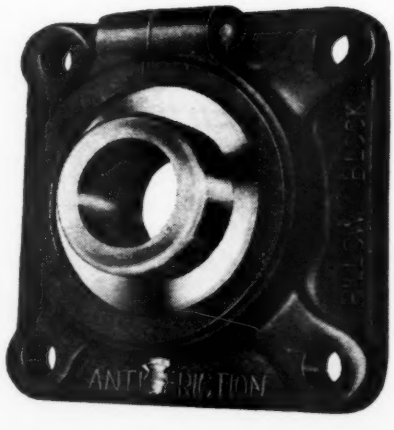
(18) Pillow blocks

Anti-Friction Bearings Company, Los Angeles, California, announces the "Imperial" self-aligning bronze pillow blocks and flange units. A split high tensile strength aluminum housing carries the spherical Naval bronze bearing. A ground adapter sleeve is inserted in bronze bearing so that one basic pillow block can serve a number of shaft diameters.

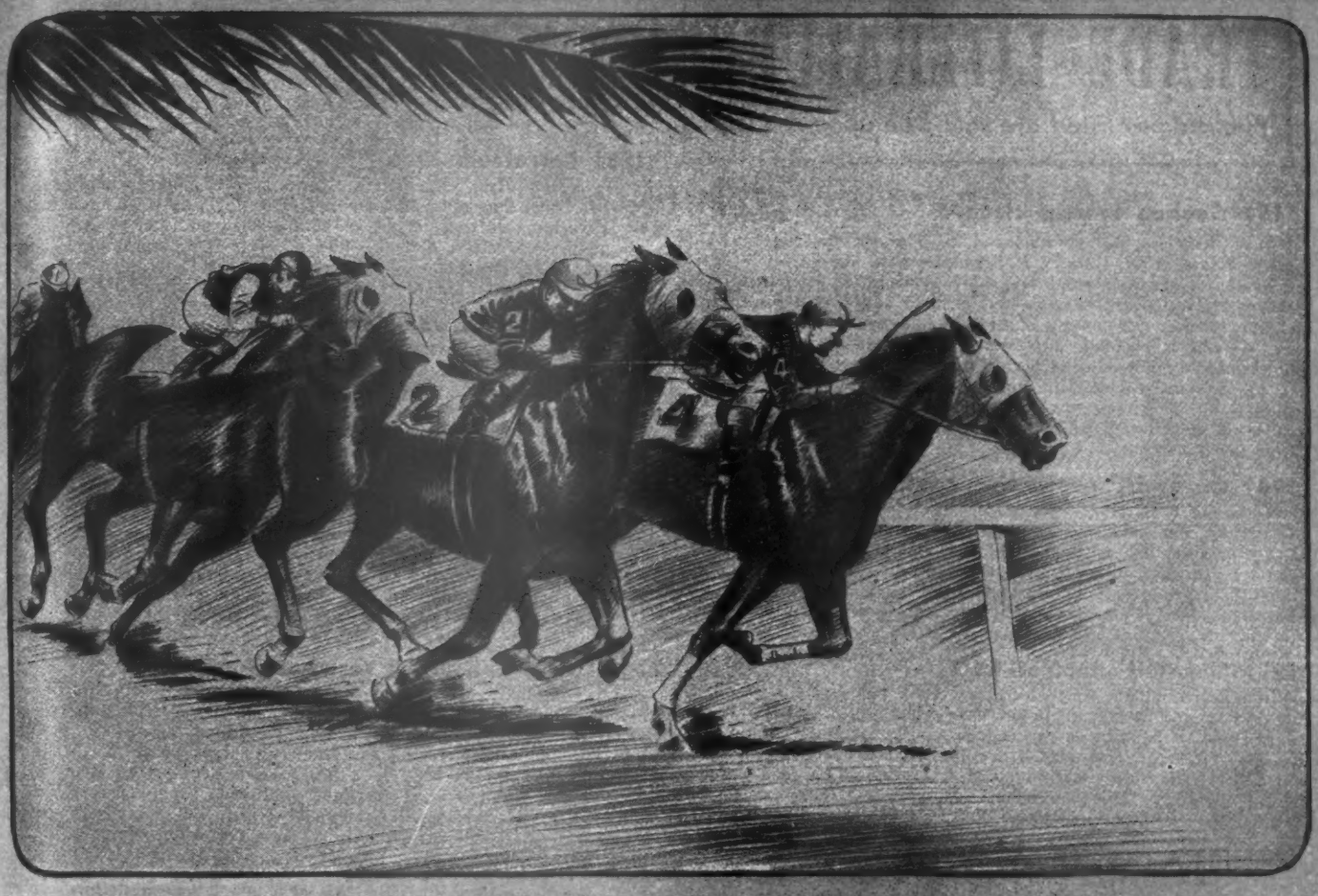
After the shaft has been located, the housing is clamped on a spherical self-aligning bronze bearing, giving a rigid bearing for taking either radial or thrust loads.

The line includes sizes from ⅝-in. to 3-in. shaft diam. in both pillow blocks and flange units. Speeds up to 5000 rpm.





WELL-KNOWN SIGNS



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IN THE OIL WORLD...

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TRADE LITERATURE

Publications listed are sent free upon request.

(19) Cooling system cleaner

Sure-Clean No. 1, manufactured by The Process Solvent Company, Kansas City, Kansas, is described as a simple but effective product for cleaning engine cooling systems. By removing scale caused by water deposits, as well as lime and rust deposits, from engine blocks, over-heating of high compression engines and cooling systems is avoided, it is stated. It is pointed out that motor blocks may permit damage by overheating without the water in the cooling system reaching the boiling point. The heat indicator may show a normal temperature even when the motor is overheating because of incrustation preventing the water from drawing the heat from the block.

(20) Carbozite protective coatings

Carbozite Protective Coatings are discussed in a recent bulletin issued by Carbozite Corporation, Pittsburgh, Pennsylvania. Carbozite coatings can be applied to steel, metal, masonry, wood, and concrete surfaces to form a dependable and economical insurance against corrosion and deterioration resulting from exposure to air, water, moisture, acids, alkalies, fumes, electrolysis, and other destructive agents, according to the manufacturer.

(21) Link-Belt electrofluid drive

Link-Belt Company, Chicago, Illinois, now has available a bulletin describing its "packaged" power unit called the Link-Belt Electrofluid Drive. This unit is a compact, motorized hydraulic combination consisting of a general purpose a-c. induction motor flange-mounted on a sturdy housing containing a hydraulic coupling, also called a "fluid coupling." This equipment was described in the November issue of *The Petroleum Engineer*.

(22) Ideco rambler rig

International Derrick and Equipment Company's Rambler Rig is the subject of a new bulletin. Used for drilling and servicing operations, this rig is equipped with hydrair hoists (hydraulic power plus air clutches) and Ideco Kwik-Lift masts.

(23) Haydite—lightweight aggregate

Haydite Manufacturers, Kansas City, Missouri, producers of lightweight aggregate, have issued a bulletin describing their product. According to the manufacturer, by the use of Haydite aggregate, concrete fully one-third lighter in weight than natural aggregate concrete (sand, crushed stone, and/or gravel) can be produced. Haydite aggregate concrete is also said to have other physical properties, such as fireproofing and behavior under severe atmospheric conditions, that are superior to natural aggregate concrete.

(24) How to organize a research department

How to organize a working industrial research department is the subject of a new handbook published by the Standard Oil Company of California under the title, "The Coordination of Motive, Men and Money in Industrial Research."

The study originally was undertaken to analyze the organization and management of Standard of California's own subsidiary, the California Research Corporation, for comparison with other leading industrial research institutions. The study later was broadened to examine all phases of organization and business management practices in industrial research.

(25) Diesel electric sets

The wide usage of diesel electric sets, which in many instances has brought upward steps in living standards, is described by words and in pictures in a new publication, "Electricity by Caterpillar." The booklet is released by Caterpillar Tractor Company, Peoria, Illinois.

(26) Positive displacement meters

Positive displacement meters are the subject of Bulletin 40-B-14, issued by Roots-Connersville Blower Corporation, Connersville, Indiana. This is a 16-page booklet in two colors, including the cover, and is elaborately illustrated with halftones of shop and installation views, sectional drawing, and proof curves of meter tests.

Construction features and advantages are discussed at some length, and a table of sizes, capacities, etc., is included. Roots-Connersville meters are built for pressures of 25, 50, and 125 lb, in the standard sizes, and steel-encased meters, for line pressures of 300 lb. upward, are also available on special order. Thirty-nine meter sizes are listed in the table, ranging from 2½ in. by 7 in. to 32 in. by 96 in.

(27) Bulletin on flame cutting

Joseph T. Ryerson and Son, Inc., steel distributors, have issued a new, illustrated bulletin on flame cutting that describes their facilities for producing plain and intricate shapes from steel plates. A number of typical flame cut sections are shown along with information regarding the use of irregular shaped steel plates in both production and maintenance work.

(28) Petroleum 1946

"Petroleum 1946," by Merrill Lynch, Pierce, Fenner and Beane. Merrill Lynch has published another economic review of an industry, focusing this time on the oil industry. In addition to an overall picture of prices, demand, fuel oil, refining, natural gas, and foreign trade, the financial and productive status of individual oil companies is presented.

(29) Petroleum sales training

The Petroleum Educational Institute, Los Angeles, California, has recently published the booklet, "Petroleum Sales Training," which should be of interest to the employer and employe alike. It puts special emphasis on the need for a fundamental training program for petroleum salesmen, in order that they may understand thoroughly the characteristics and uses of their products.

(30) Welding and cutting products catalog

The Air Reduction Sales Company has announced publication of a new 64-page general welding and cutting products catalog. Profusely illustrated, this catalog is divided into two sections: One for oxyacetylene welding and cutting gases, equipment, and supplies; the other for arc-welding machines, accessories, and electrodes. The last ten pages of the catalog are devoted to specially compiled electrode price lists.

(31) Acid and alkali resistant pumps

A new bulletin has been issued by Worthington Pump and Machinery Corporation, Harrison, New Jersey, on Worthington type CG acid and alkali resistant pumps. Additional sizes have been added to the manufacturer's line increasing the coverage to 200 ft. and capacities to 1200 gpm. All sizes are production items in Worthite, a stainless steel resistant to a wide range of corrosive conditions. The 20-page, illustrated, descriptive bulletin covers specifications, applications, sectional diagrams, performance curves, etc.

(32) Vapor saving roofs

"Vapor Saving Roofs" is the title of a new 8-page bulletin made available by the Graver Tank and Manufacturing Company, Inc. This company's expansion roof and improved floating roof of double-deck construction are fully described along with valuable information on the conservation of petroleum products in storage.

(33) Industrial protective clothing

A new 10-page booklet on its line of industrial protective clothing has been published by The B. F. Goodrich Company, Akron, Ohio. The booklet tells of the new products in this field that the company has introduced in recent months, pictures each garment, describes its functions in industry, and relates the method of construction and materials used to guarantee maximum service.

(34) Farrel gearflex couplings

A new 46-page bulletin, No. 447, entitled "Farrel Gearflex Couplings," completely describes various types of couplings for use in industrial and marine service, manufactured by the Buffalo division of Farrel-Birmingham Company, Inc.

The booklet, with the aid of many photographs, drawings and installation illustrations, gives a clear description of coupling functions, plus recommendations of the correct types for specific applications. Included also are complete engineering data with ratings, dimensions, and weights.

(35) Hydraulic oil purification

A new four-page folder issued by Honan-Crane Corporation, a subsidiary of Houdaille-Hershey Corporation, is intended to point out to operators the way to stop down time and expensive repairs on hydraulic presses, machine tools, plastics molding presses and machines, die casting presses, balers and injection molding machines, by effective purification of hydraulic oils.

(36) A-C. welders

Construction details, electrical specifications, and application data on the complete line of a-c. transformer type welders are contained in a new booklet announced by the Westinghouse Electric Corporation. Detailed information is given on the 500 and 400-amp. industrial welders for fast, steady production; the 300-amp. welder for heavier-than-average work; and the general duty welders ranging from 20 to 250-amp. Electrical specifications and performance data are presented in chart form for easy reference. The booklet is fully illustrated with interior views and close-ups of special features, as well as exterior views of each model. General application information concerning recommended electrodes is also included.

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—Mecca of skiing, fishing, canoeing, and hunting sportsmen, Trois Rivieres as Canada's third oldest and third largest port is further distinguished industrially as being the world's biggest newsprint manufacturing center. Trois Rivieres is showing solid and extraordinary growth. Seeking greater economy and better water, this fine Quebec city is turning to Layne Well Water Systems. Layne Water producing equipment is already serving military camps, airports, ammunition and aluminum foil plants—as well as the nearby city of Cap de la Madeleine.

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Neither geographic location nor climatic conditions affect the high efficiency, long life, low operation cost or unmatched dependability of the world famous Layne Well Water Systems. For literature, address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

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This fifty-foot length of 3-inch Thermoid* Powerflex Rotary Hose snaked out shows no strain or kink in the hose at any time. Thermoid Powerflex PRESSURE SEAL Rotary Hose can be coiled into smaller diameter without injury than any type of rotary hose — whether light or heavy duty.

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Rotary Brake Blocks—Woven Oil Field Brake Linings—Slush Pump Hose—Flexible Discharge Unit Hose—Production and Refinery Hose of all types—V-Belts and Drives—Oil Country Belting—Stuffing Box Rings—"No Wip" Line Savers—Wire Line Turn Backs—Pin Type Pipe Protectors—Molded Products

Thermoid Rubber

Liquefied petroleum gas in 1946

By G. G. OBERFELL*
and R. W. THOMAS,†
Phillips Petroleum Company

Installation of liquefied petroleum gas storage tanks by large utility company for augmenting gas supply.

● **Introduction.** Anyone studying the growth of the liquefied petroleum gas industry will at once recognize the tremendous strides made in volume of product marketed. Particularly is this growth impressive when one considers that as of the end of 1946 the annual marketed volume is 13 times the volume that it was ten years ago. Not only has the increase in the marketed volume of these products approached staggering proportions but in addition the methods of handling, selling, and utilizing these products have developed to a stage of refinement and acceptance that liquefied petroleum gas now is regarded as a necessary and dependable fuel equal to or better than the best available materials for similar use. The past year is the first full year since mid-1941 in which the industry has operated without any direct wartime restrictions. The development and growth of the industry during 1946 would have reached even greater proportions had it not been so unduly restricted by the same material and manpower shortages as were experienced by most of the other industries in the country during this readjustment period.

● **Total sales.** It is worthy of particular note that the total estimated marketed production of LP-Gas during 1946 amounted to a little more than three times the marketed production of LP-Gas in 1941, the last full year of production and sales prior to the war. It is estimated that the total marketed production of LP-Gas in 1946 (1,425,000,000 gal.) exceeded the marketed production of 1945 by 33.5 per cent. Particularly for household use and for gas manufacturing the demand for LP-Gas far exceeded the marketed volume, which was limited by the unavailability of utilization and transportation equipment.

● **Domestic use of LP-Gas.** It is estimated that at the close of 1946 there were approximately 3,500,000 homes using liquefied petroleum gas for household purposes. In addition to these household uses, this particular classification of marketed production (See "Domestic" in the table) includes the many other requirements for which these customers desired LP-Gas, such as irrigation pumping, tractor fuel on the large farms and ranches, chicken brooding, and the many other demands that existed for a fuel of this nature. Included in this classification of marketed production there is a considerable volume that was used for industrial purposes, internal-combustion engines, and for gas manufacturing purposes. This consumption was tabulated in this classification because it was sold by producers to distributors whose principal sales were for household purposes.

Despite the shortage of steel for tanks, cylinders, and appliances, which limited the number of new installations, the increased use of the gas on the part of continuing customers and the demand on the part of new customers installed during the year brought the total estimated "domestic" consumption to 763,000,000 gal., an increase of 43.1 per cent over 1945. This large increase was possible only because of the initiative and ingenuity displayed by the marketers. One evidence of this was the development of distribution methods by which a far greater number of customers was served with a given number of cylinders than was thought possible a few years ago.

Manufacturers are recognizing the tremendous demand for LP-Gas consuming appliances and their increased interest in this market is worthy of note. Another interesting trend is the increased use of meters for measuring household consumption.

The past year has seen the greatest demand for new bulk stations, both on the part of companies already in the business as well as by newcomers. This has resulted in making the distribution of LP-Gas to the consumer more economical because of shorter hauls, a factor that brings lower cost to the operator and an advantage in obtaining greater consumer saturation. Indications are that this trend will continue. It is estimated that approximately 2500 bulk distributing plants are in operation now.

● **Industrial use.** A number of industries were greatly curtailed or completely shut down in the conversion from wartime to peacetime activities and very little growth in LP-Gas volumes consumed for industrial use was experienced during the past year. Because of material and man-power shortages an increased demand for LP-Gas in existing industrial installations and in new installations did not materialize. In 1946 it is estimated that 257,000,000 gal. were used. This represents an increase of 0.2 per cent over that consumed in 1945.

In addition to industrial uses, LP-Gas sold directly by producers for fueling internal-combustion engines is included in this tabulation. A certain growth in this use was evident but much of the product so used was sold by resellers and included in the domestic classification.

With increased distribution of natural gas it is to be expected that some LP-Gas will be replaced with this fuel. In a number of conversions natural gas will be purchased under high cost peak load prices or with shutoff provisions. In such cases LP-Gas installations will be used for standby. As industrial reconversion progresses and manufacturers build many of their plants that are now in the planning stage, sales for industrial uses will again expand.

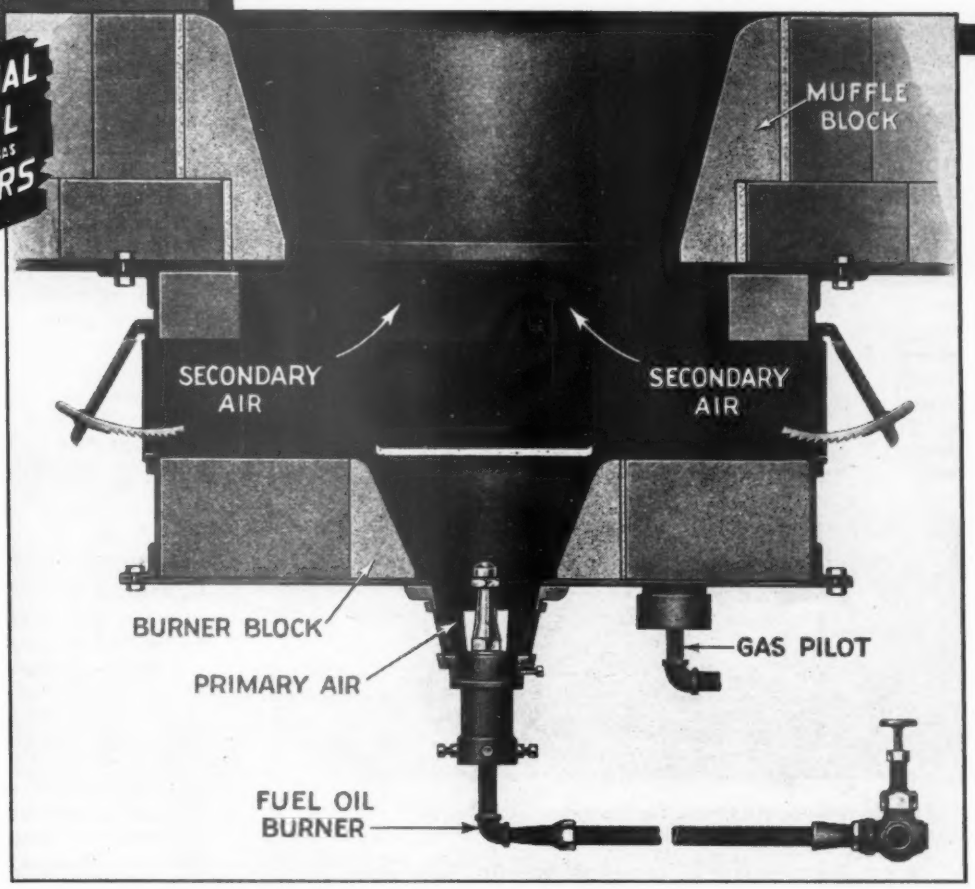
● **Use of LP-Gas by utilities.** The largest percentage increase in consumption for LP-Gas during the past year was by utility companies for gas manufacturing. The estimated sales volume was 80,000,000 gal., an increase of 48.6

*Vice president in charge of Research and Development, Phillips Petroleum Company.
†Manager, Research and Development, Phillips Petroleum Company.

ONE SATISFIED REFINER-OWNER says:

"We have used this oil burner unit in our asphalt heater almost continuously for over six years. Its all around performance has exceeded our original expectations. Our operators are enthusiastic about it. We are specifying it for several up-fired stills that we are about to build."

NATIONAL AIROIL FUEL OIL - GAS BURNERS



This illustration is an exact reproduction of the oil burner unit installation about which the above quoted statement was made.

NATIONAL AIROIL BURNER COMPANY is a pioneer in the development and successful application of up-fired oil burner units to stills and heaters. The outstanding and exclusive features of these oil burner units are:

1. **Easy to light off quickly on a cold setting.**
2. **Easy to adjust for most desirable flame characteristics throughout a wide capacity range.**
3. **Assure smokeless combustion with a minimum of excess combustion air and stack draft.**
4. **Provide stability of ignition with a bright flame to insure the maximum transfer of heat by radiation to wall tubes.**

These advantages are time- and money-savers. Can you afford to be without them?

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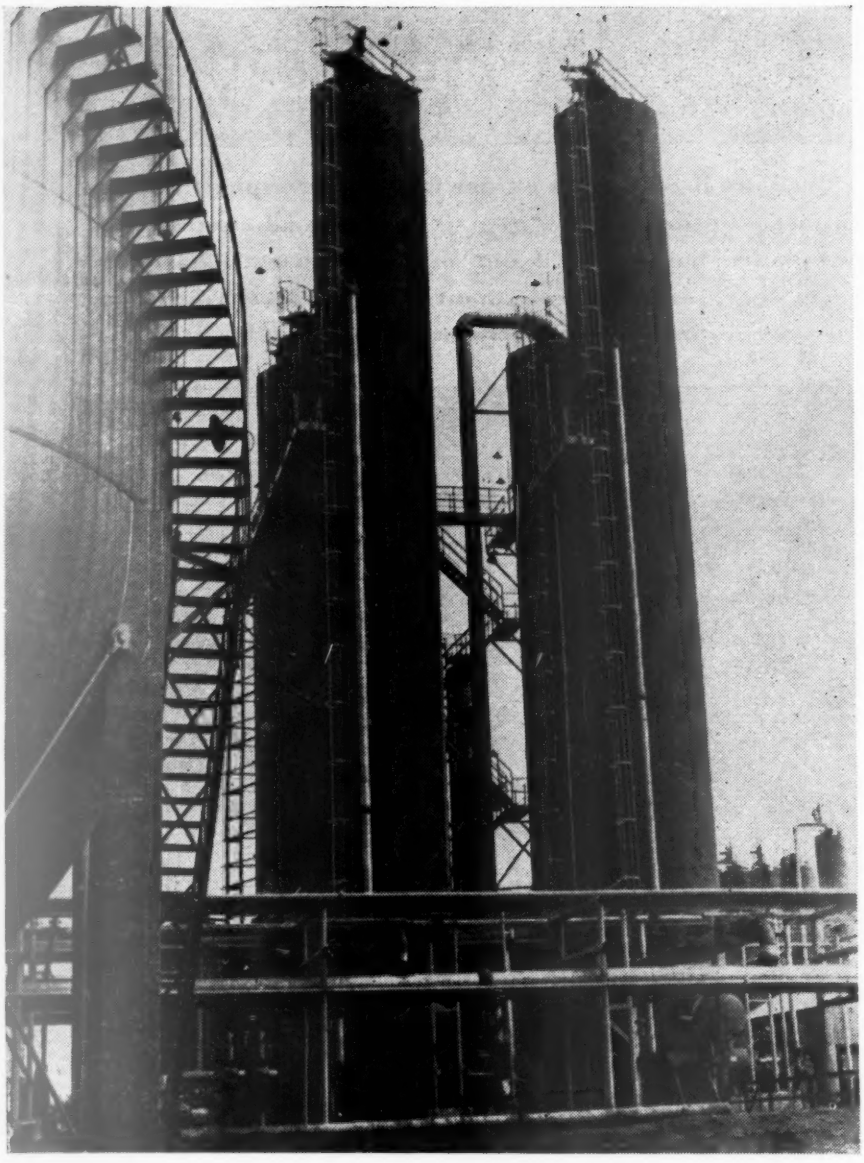


Fractionation equipment for recovery of LPG.

per cent over 1945. Many gas manufacturing plants operated throughout the war years in a state of low efficiency due to inability to procure replacement parts or new equipment. A number of these plants have been converted to LP-Gas during the past year with an appreciable economic advantage. There are now more than 300 towns served by gas manufacturing plants depending upon liquefied petroleum gas for their entire requirements.

An increasing number of homes were converted to natural or manufactured gas for house heating. As a result utilities are experiencing large winter peaks in the demand for house heating. The additional house-heating load has taxed their manufacturing facilities or transmission lines beyond their physical limits, resulting in the need for additional gas producing and transmission facilities. To satisfy this peak load requirement many utilities are installing LP-Gas storage to supply this periodic deficiency in gas supply. As the utilities' peak demand occurs at approximately the same time as does that of the LP-Gas industry, it is necessary for the utilities to install sufficient LP-Gas storage to satisfy this seasonal demand. Due to the shortage of steel for manufacturing storage tanks only a portion of these projected installations were completed in 1946. Part of this huge peak load demand for LP-Gas may be temporary, pending construction of additional gas manufacturing facilities or additional natural gas pipe lines; however, a large portion of this demand can be considered permanent.

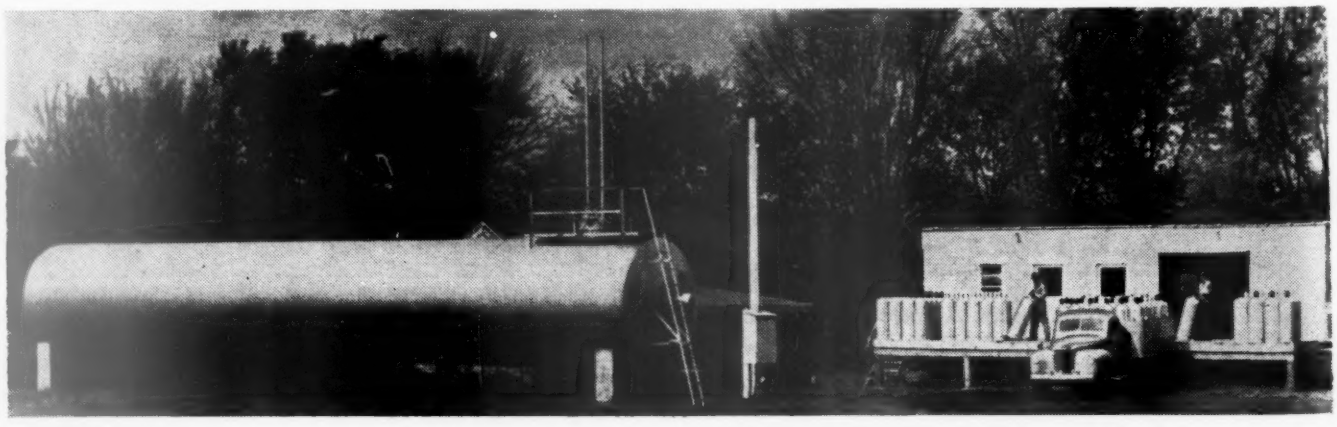
● **Chemical uses.** Liquefied petroleum gases make excellent feed stocks for the production of certain intermediate materials in the manufacture of chemicals. As a result of the impetus given by the war activity in synthesizing a great number of chemicals, this industry has continued to grow since the termination of hostilities.

Assuming that the demands of the same general type of chemical manufacturing activity are included in this classification as in previous tabulations, it is expected that during 1946 approximately 325,000,000 gal. of LP-Gas will have been consumed. This represents an increase over 1945 of 44.8 per cent. The above consumption excludes the C_3 and C_4 hydrocarbons used for the production of motor fuel, aviation gasoline, and synthetic rubber components.

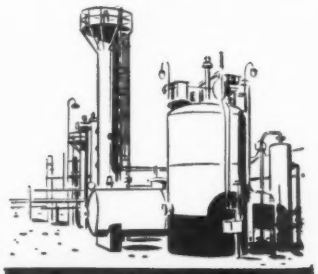
Large quantities of LP-Gas are still being used in the manufacture of synthetic rubber components. The plants employing raw materials derived from petroleum are still in operation and in general have not curtailed their output, but rather have endeavored to produce the maximum quantity possible. Therefore, the demand for this purpose has been high through 1946 and will probably continue in approximately the same amount through 1947.

● **Industry activities.** Accompanying the growth of the LP-Gas industry has

Typical liquefied petroleum gas cylinder filling plant.

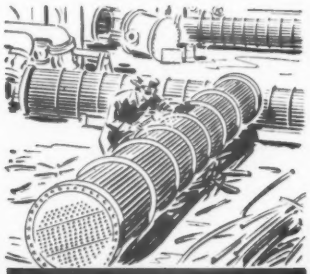


THESE 8 ADVANTAGES OF PETRECO DESALTING ARE REFINERY MONEY SAVERS



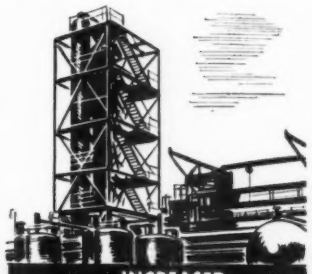
1 HIGH PERCENTAGE SALT REMOVAL

Petreco Desalting usually insures a salt removal of 90% or better, with 98% not uncommon.



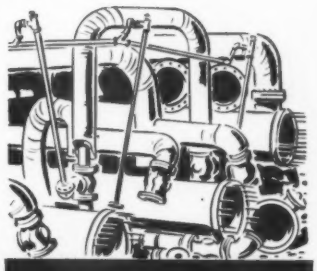
2 CORROSION PREVENTION

Petreco Desalting reduces corrosion by curtailing the evolution of HCl.



3 INCREASED CRACKING EFFICIENCY

A refinery comparison of two cracking stills shows a ½ cent per barrel gain for the still handling desalted crude—after desalting costs were met.

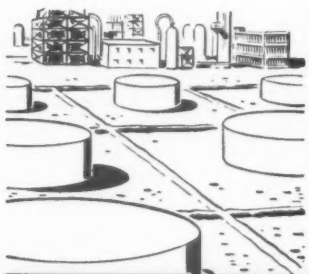


4 LESS "DOWN TIME"

"Down time" is frequently reduced as much as 50 to 90% wherever Petreco Desalters are installed.

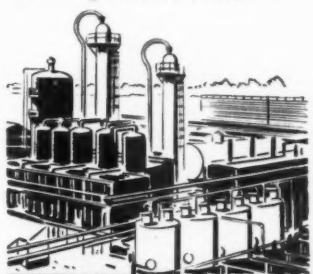
5 ELIMINATION OF PLUGGING

A Petreco Desalter virtually always eliminates salt plugging.



6 TANK BOTTOMS DISPOSAL

Many refiners materially increase tank storage space by adding tank bottoms to the crude being desalted.



7 INCREASED REFINING CAPACITY

Increases in refining capacity varying from ten to several hundred per cent are frequently credited to Petreco Desalters.

8 PETRECO SERVICE

Petreco engineers supervise every desalter installation, and inspect equipment periodically—they are constantly "on call."

In many cases, the savings accruing from one or two of these advantages are more than enough to defray the nominal cost of Petreco Desalting.

For complete information, and a tentative plan for Petreco economies in your operations, have a Petreco engineer call on you. Economical process improvements have frequently started with a Petreco conference. There is no charge for this service.

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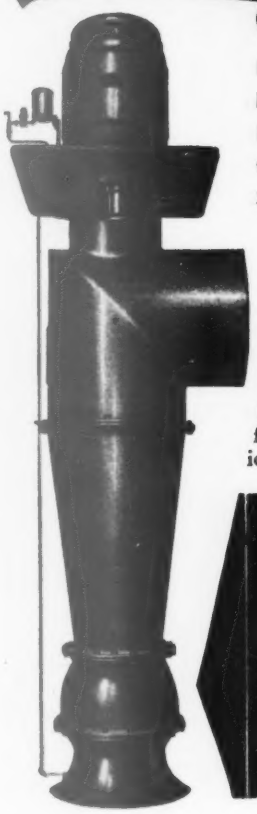
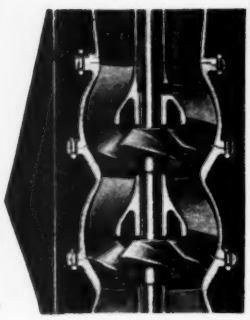
Hydro-Foil PUMPS
Move huge volumes of water against low and medium heads



PEERLESS MIXED-FLOW PUMPS
CAPACITIES: UP TO 220,000 G.P.M.

Cutaway view of Mixed-Flow multi-stage pump impeller and bowl construction revealing high efficiency impellers utilized for more economical water lift.



To rapidly move and re-move maximum amounts of water.

The most modern principles of aero and hydro-dynamic design are embodied in Peerless Mixed-Flow pump design and construction, attaining new high efficiencies in large volume water lift and lowering overall maintenance and pumping costs.

Numerous successful applications of Peerless Mixed-Flow Pumps include: drainage; sewer and flood control service; dewatering; irrigation water diversion; flooding of agricultural lands; industrial and process work including condensers, circulation of liquors, etc.

PROPELLER TYPE PUMPS

Peerless pumps, embodying the Hydro-Foil principle, are also available in the propeller type and are capable of handling identical capacities of the Peerless mixed-flow pump. Request Bulletin B-148 on design, construction and application data of these two outstanding types of Peerless Pumps, for large-volume water pumping.

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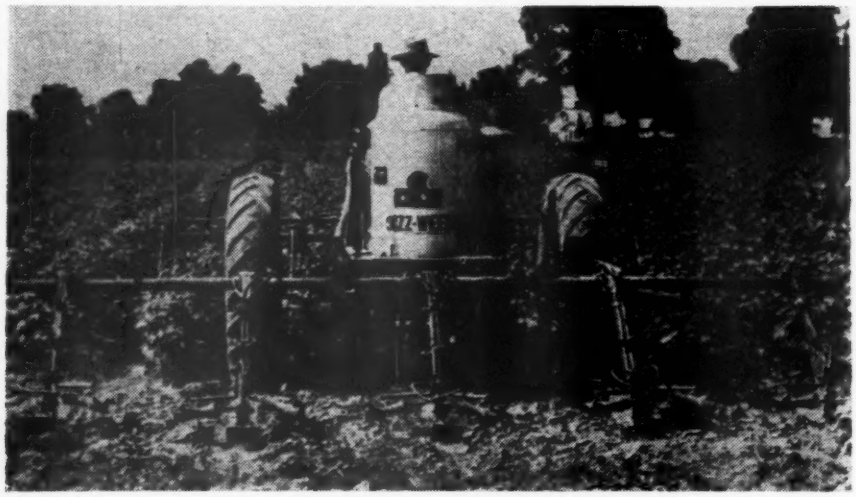

Tractor drawn equipment for flame weeding with LPG.

MARKETED PRODUCTION OF LP-GAS

Year	Total sales		Distribution—1000 gal. annually							
	Gallons in thousands	Per cent increase	Domestic*	Per cent increase	Industrial and miscellaneous	Per cent increase	Gas manufacture	Per cent increase	Chemical† manufacture	Per cent increase
1922	223	..								
1923	227	24.4								
1924	376	36.0	Sale of liquid petroleum gas confined primarily to bottled gas business prior to 1928							
1925	404	7.2								
1926	465	15.2								
1927	1,091	134.6								
1928	4,523	314.6	2,600	..	400	..	1,500	..	..	..
1929	9,931	119.6	5,900	126.9	1,500	275.0	2,500	66.7	..	..
1930	18,017	81.4	11,800	100.0	2,200	46.7	4,000	60.0	..	..
1931	28,770	59.7	15,295	29.6	7,172	226.0	6,303	57.6	..	..
1932	34,115	18.6	16,244	6.2	8,167	13.9	9,703	53.9	..	..
1933	38,931	14.1	16,626	2.3	13,987	71.3	8,318	—14.3	..	..
1934	56,427	44.9	17,681	6.3	32,448	132.0	6,298	—24.3	..	..
1935	76,855	36.2	21,380	20.9	47,894	47.6	7,581	20.4	..	..
1936	106,652	38.8	30,014	40.4	67,267	40.4	9,371	23.6	..	..
1937	141,400	32.6	40,823	36.0	62,610	*	11,175	19.3	26,792	..
1938	165,201	16.8	57,832	41.7	62,694	0.0	12,386	10.8	32,299	20.5
1939	223,580	35.3	87,530	51.4	93,723	49.4	15,435	24.6	26,892	—16.7
1940	313,456	40.2	134,018	53.1	124,482	34.5	20,285	31.4	34,671	29.0
1941	462,852	47.7	220,722	64.7	172,669	38.6	25,255	24.5	44,206	27.5
1942	585,440	26.5	299,559	35.7	201,447	16.7	31,366	24.2	53,038	20.0
1943	675,233	15.3	339,380	13.3	242,978	20.6	37,519	19.6	55,356	4.4
1944	898,071	33.0	445,617	31.4	254,590	4.8	45,879	22.3	151,985	175.0
1945	1,067,979	19.0	533,262	19.7	256,577	0.8	53,849	17.4	224,291	47.5
1946	1,425,000	33.5	763,000	43.1	257,000	0.2	80,000	48.6	325,000	44.8

*See text for definition of domestic uses.

†See text for definition of chemical uses.

*Not comparable due to segregation of chemical manufacturing.

Remarks: In this table "total sales" for all years except 1946, were obtained from U. S. Bureau of Mines reports. "Distribution" for the years 1931 to 1945, inclusive, was obtained from the same source. All other volumes were estimated by the writers. The total sales volume includes all liquefied petroleum gases (propane, butane, and propane-butane mixtures) when sold as such. Until 1944 the sale of pentane when sold for any purpose other than motor fuel blending was included. Since then it has been excluded. It does not include butane when blended with heavier petroleum fractions for motor fuel purposes. Intercompany sales transactions such as purchases of liquefied petroleum gases by one company from other companies and resold as liquefied petroleum gases, have been eliminated in order to avoid duplication of sales figures. The data do not reflect sales of liquefied petroleum gases used directly by the producer at the point of production, for fuel, polymerization, solvent de-waxing, etc. Neither do the figures include sales of hydrocarbons to plants manufacturing synthetic rubber or aviation gasolines or their components.

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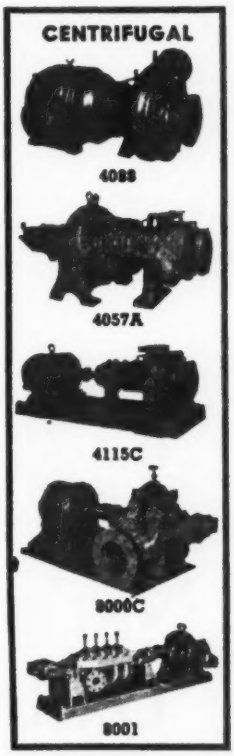

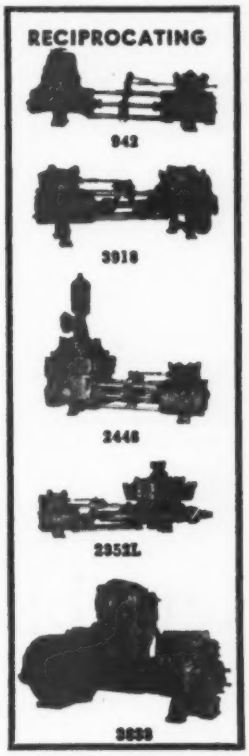

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been the development of high safety standards. This activity has been advanced by national and state associations comprised of industry members, as well as by the organizations of the individual companies. One of the foremost accomplishments in establishing minimum safety requirements was the revision of the National Board of Fire Underwriters Pamphlet No. 58 entitled "Standards for the Design, Installation and Construction of Containers and Pertinent Equipment for the Storage and Handling of Liquefied Petroleum Gases as Recommanded by the National Fire Protection Association." The Liquefied Petroleum Gas Association, a national organization, is constantly active in developing these standards. Many states and municipalities have adopted these standards as the basis for statutes and regulations to govern conduct of the industry's activities.

An effective publicity campaign has been continued during the year by the Liquefied Petroleum Gas Association. Electricity continues to strive for a leading role as competitor to LP-Gas for the household uses.

● **Supply.** During the war large quantities of liquefied petroleum gases were recovered in refineries for use in the production of aviation gasoline and synthetic rubber components. Since the cessation of hostilities a large portion of the facilities producing aviation gasoline components have been employed for other purposes. A very large quantity of the butane (and butylenes) formerly used for producing war materials is now going into motor fuel, however, a good portion of it has been made available for use by the LP-Gas industry. It appears that butane will continue to command a higher price than propane due to the demand for butane in motor fuel.

From available information it appears that most of the increased volume of LP-Gas marketed in 1946 over 1945 was obtained from refinery sources. Large additional quantities of LP-Gas are potentially available both from natural gas sources and from refinery sources. With firmer prices for propane in the future it will be possible for producers to justify its diversion from other end uses and to invest in recovery and purification equipment to bring additional product to commercial specifications.

One of the greatest shortages encountered during the past year has been in transportation facilities. Because of limitations imposed during the war on the construction of new LP-Gas tank cars, the industry's fleet was taxed to capacity at the beginning of the year. The feverish attempts of the industry to enlarge this fleet have met with no success due to the shortage of steel and due to a program of constructing tank cars for ammonia to assist in a fertilizer manufacturing program sponsored by the government. An allocation of steel for a tank car construction program has been approved by the government and should help alleviate this shortage in 1947. There are approximately 3400 tank cars transporting liquefied petroleum gas today and there are about 2300 new tank cars on order. The majority of these new cars have been on order for some time and it is impossible now to say when their construction will be completed. Considerable effort has been devoted to stretching the movement of LP-Gas in truck transports to assist in overcoming the tank car shortage.

To overcome the inherent burden on the industry's facilities to cope with the winter requirements an increasing demand prevails for the installation of large volume storage capacity at all points in the distribution channels.

● **New Developments.** The use of LP-Gas for the cultivation and preservation of agricultural products has shown a healthy increase. Flame weeding passed from the development stage to that of successful commercial application. LP-Gas is finding use in the many new dehydration plants. The experimental use of flame to promote the culture and ripening of products is continuing and the results appear promising.

The growing demand for the use of LP-Gas in foreign countries was keenly evident throughout the year. Some petroleum companies having international organizations are now more aggressively developing these markets.

The demand for long distance transportation of LP-Gas in large quantities has accelerated plans for barge and tankship design and construction.

★ ★ ★

Republic National Bank of Dallas

Statement of Condition December 31, 1946

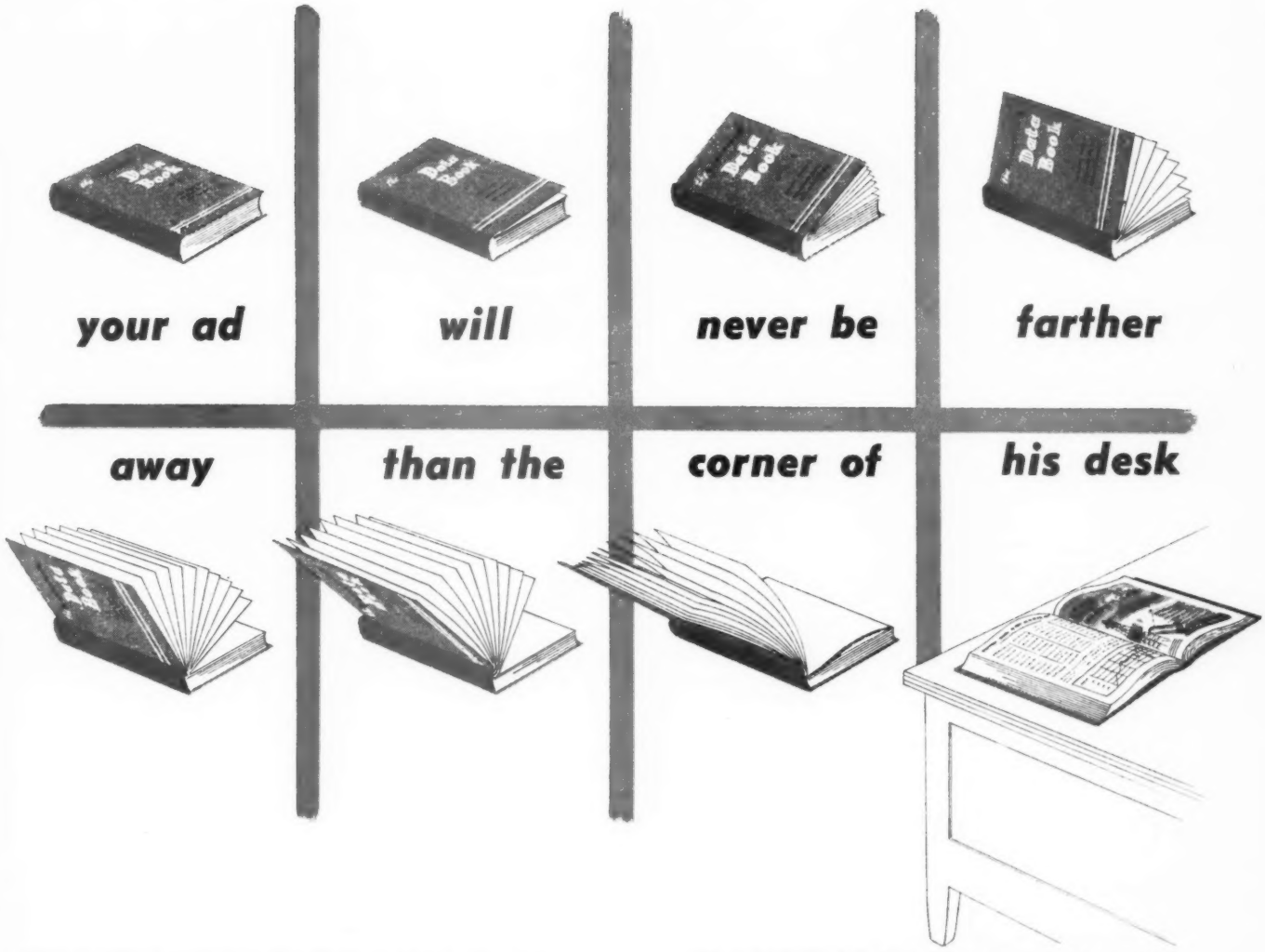
RESOURCES

Cash and Due from Banks	$ 85,895,032.81
U. S. Government Securities	42,406,284.17
State, Municipal, and Other Securities	3,194,427.56
Stock in Federal Reserve Bank	600,000.00
Loans and Discounts	136,788,020.60
Banking House	2,205,141.69
Furniture and Fixtures	285,073.77
Real Estate for Bank Expansion	259,669.22
Customers' Liability—Acceptances and Letters of Credit	5,174,898.78
Total	$276,808,548.60

LIABILITIES

Capital	$ 10,000,000.00	
Surplus	10,000,000.00	$ 20,000,000.00
Undivided Profits		2,150,507.93
Reserve for Taxes, Etc.		1,597,521.73
Acceptances and Letters of Credit		5,174,898.78
DEPOSITS:		
Individual	$163,247,883.62	
Banks	79,795,331.27	
U. S. Government	4,842,405.27	247,885,620.16
Total		$276,808,548.60

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION



Early in 1947 a copy of *The Petroleum Data Book, first* and *only* single-volume source of information ever published on all phases of the oil and gas industry, will hit the desk of every foreign and domestic buyer of petroleum equipment—*and will stay there* for 12 months of constant use by top management and operating personnel.

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OFFICIAL SOURCE OF INFORMATION FOR THE WORLD'S OIL AND GAS INDUSTRY

Conversion of natural gas to liquid fuels*

By **R. C. ALDEN,** *Director of Research,* Phillips Petroleum Company

About 25 years ago, Franz Fischer and Hans Tropsch of the Kaiser Wilhelm Institute in Germany, commenced a systematic laboratory study of catalysts and conditions required for the efficient production of liquid and solid hydrocarbons from water gas. Water gas was already being produced commercially in Germany in tremendous quantities for use in the production of synthetic methanol and as a source of hydrogen for the ammonia synthesis, hydrogenation of coal, and other hydrogenation processes. By 1925 these two investigators had succeeded in developing an active cobalt catalyst that could be used at near atmosphere pressure to give good yields of liquid hydrocarbons.

On the assumption of power by Hitler and the formation of the Third German Reich the process was pushed forward with increased vigor as were all industrial processes that enhanced the self-sufficiency of the German Nation in preparation for the coming struggle. By 1933, the first large-scale installation was on stream at Oberhausen. The Fischer-Tropsch process showed a steady rise in commercial production from this time on until the beginning of the war.

According to the U. S. Strategic Bombing Survey, Germany was producing only a third of her fuel requirements in 1936. In 1939, through installation of more Fischer-Tropsch and coal hydrogenation plans, Germany went to war with reserves of 3.1 months' war needs of aviation gasoline and 1.9 months' needs of motor fuel[1]. This was certainly sufficient as planned for a blitzkrieg war. But as we know, the blitzkrieg war lulled into a "phony" war and then launched into a war of such gigantic proportions that for the duration, Germany fought successive crises of insufficient oil stocks. Near the end of the war, she had scarcely enough reserves to wet the bottoms of her tanks.

At the time of the invasion of Poland, Germany had seven large hydrogenation plants and seven Fischer-Tropsch plants operating. At least four more hydrogenation plants, including a large one at Poelitz, and two more Fischer-Tropsch plants were under construction. During the "phony stage" of the war, between September, 1939, and May, 1940, Germany's synthetic oil plant capacity was increased roughly from 13,100,000 to about 16,600,000 bbl. annually[2].

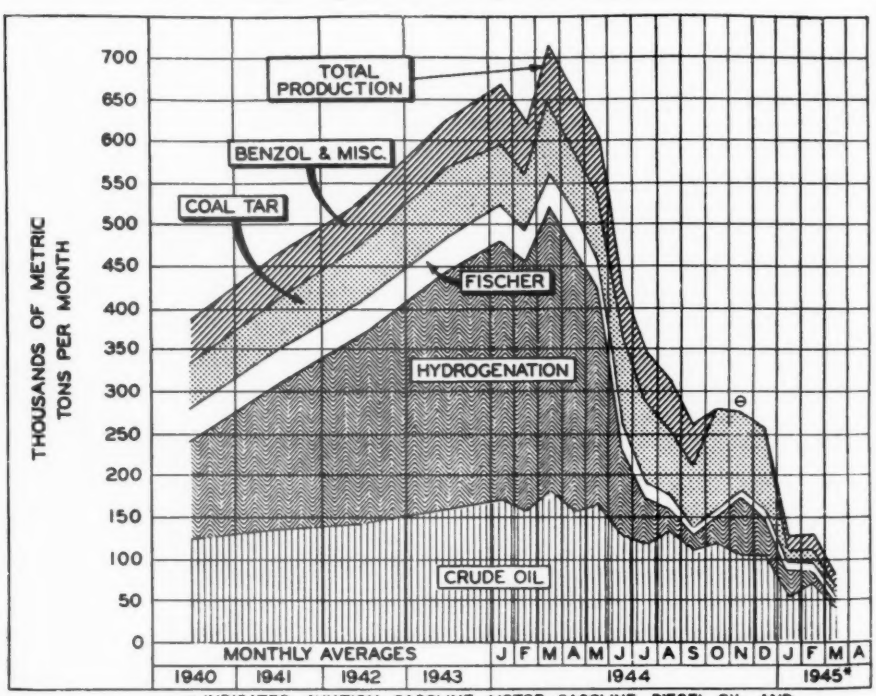
In Fig. 1, is shown the German production of petroleum products during the war years[3]. The most striking feature of this plot is the precipitous decline early in 1944 as a result of the inauguration of the Allied strategic bombing missions. Also to be noticed is the tremendous increase in war-time production of synthetic oil by hydrogenation of coal, dwarfing all other methods of production. Actually, Fischer-Tropsch plants played a relatively minor role in the German synthetic oil program during the war. Several explanations have been offered. In the first place, it appears that a political race was going on between I. G. Farbenindustrie, which owned the hydrogenation plants and patents, and the Ruhrchemie, which owned the Fischer-Tropsch plants and patents. I. G. won the race in spite of the fact that their process was the more costly. But there was also at least one sound technical reason why the coal hydrogenation process was favored. It produced directly gasoline of a higher octane rating suitable for aviation base stock. The Fischer-Tropsch process on the other hand produced a highly paraffinic product that would be converted into motor fuel or aviation fuel only by drastic refining steps.

The development in Germany of Fischer-Tropsch type processes utilizing iron catalysts, producing high octane gasoline directly, was only in pilot plant stage at the end of the war and thus came too late to participate in the German war effort. Such processes, had they been developed earlier, may have given the Fischer-Tropsch process a more significant war role in Germany. Before discussing American developments, some of which are proceeding to commercial application and which have improved greatly the German processes using iron catalysts both technically and economically, it might be interesting to point out some of the engineering features of commercial scale German plants that were operated during the war.

Fig. 2 shows a flow sheet for the typical German plant of the atmospheric pressure type[4]. This was the most common type of plant used in Germany. Only a very small percentage of Fischer-Tropsch output was produced by the so-called medium pressure process.

Water gas for Fischer-Tropsch operation was universally produced by all plants in the Ruhr by the conventional water-gas reaction utilizing coke. The re-

FIG. 1. German production of petroleum products[3].



* INDICATES AVIATION GASOLINE, MOTOR GASOLINE, DIESEL OIL AND LIQUIFIED GAS ONLY.
Θ INCLUDED WITH COAL TAR, OCT.-DEC., 1944

*Presented before California Natural Gasoline Association, Los Angeles, October 11, 1946.

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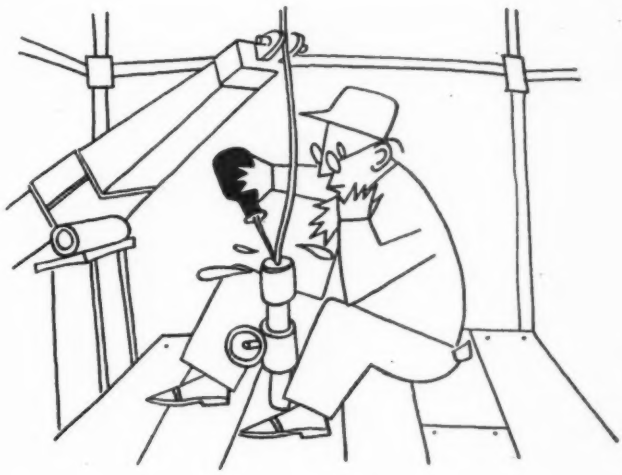

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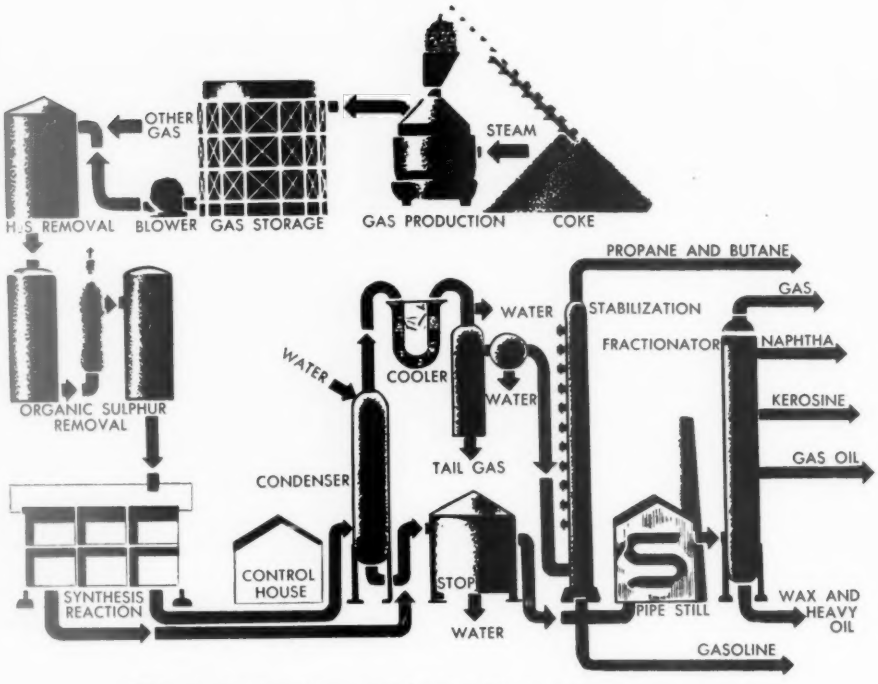

FIG. 2. Production of oil by the Fischer-Tropsch process[4].

action was carried out in standard, intermittent water gas sets involving no significant differences from well-known American practice.

In order to obtain the higher ratio of hydrogen to carbon monoxide required for the standard Fischer-Tropsch operation, it was necessary to pass a portion of the water gas through converters containing the so-called shift catalyst, whereby carbon monoxide was converted into hydrogen and carbon dioxide. This step is not shown on the flow sheet. Steam was introduced with the gas and the conversion was carried out at about 900°F. The carbon dioxide was subsequently scrubbed out and the remaining hydrogen combined with the unconverted portion of water gas to give a gas containing approximately two parts of hydrogen to one of carbon monoxide plus 8 to 10 per cent impurities or inerts such as nitrogen, methane, and carbon dioxide.

Although the conventional water gas reaction was used in all plants for making water gas, at least two plants in the Ruhr and possibly others were supplementing their production of synthesis gas from coke by processes based on either coke over gas or brown coal.

Sulphur is a troublesome element in the Fischer-Tropsch process and must be removed from synthesis gas before entering the synthesis chambers. The tolerance is about 0.1-0.2 grains per 100 cu. ft. The removal is carried out in two stages. Stage 1 is the removal of hydrogen sulphide and stage 2 the removal of organic sulphur such as carbon disulphide and mercaptans. In Germany the hydrogen sulphide was generally removed by the well-known iron oxide method consisting merely of contacting synthesis gas with iron oxide at normal temperature. Organic sulphur was generally removed by contacting the synthesis gas with a catalyst at temperatures varying from 350°F. with fresh catalyst to 540°F. with nearly exhausted catalyst. A captured sample of catalyst from the Rheinprussen plant showed ferric oxide and sodium carbonate to be the chief constituents.

The synthesis gas with sulphur removed passes into the reaction chamber where the synthesis of hydrocarbons takes place. The temperature in this converter varies with the age of the catalyst from about 356 to 383°F.; the pressure is substantially atmospheric. The catalyst chamber is cooled indirectly by circulating water. The products and unconverted gas are separated in the condenser and cooled by a water spray. Unconverted gas containing considerable light ends passes either to large vessels containing activated carbon or to a cooler where light oil vapors and gaseous hydrocarbons are recovered. Product is obtained from activated carbon by periodical steam-stripping. The heavier condensed product is separated from the water layer and is subsequently refined and stabilized by conventional methods.

The flow diagram does not illustrate vividly enough the tremendous amount of equipment required in the conventitonal German process. The Meerbeck plant[5], for example, having an installed capacity of about 1500 bbl. per day of total product had 11 gas preparation units covering 2½ acres of land, and in addition:

Four parallel sets of hydrogen sulphide removal towers each 30 ft. high and 35 ft. in diameter.

Five parallel sets of organic sulphur removal towers 30 ft. high and 12 ft. in diameter.

One hundred Fischer-Tropsch reactors each 8 by 10 by 15 ft. in size.

Two adsorption systems each containing seven towers.

Two stabilization systems.

Two distillation plants.

The heart of the Fischer-Tropsch plant is the synthesis chamber and nothing shows the complexity of the German process more than this section of the plant. As previously stated, 100 of the typical sets of atmospheric pressure converters are required for 1500 bbl. per day capacity. These chambers are small and complicated, designed to remove the enormous heat of reaction which is about 7000 B.t.u. per lb. of product. Each chamber consists of an array of metal fins about 0.28 in. apart. Transversely through these fins are cooling tubes about 1.5 in. in diameter through which water flows as a cooling agent. The headers for collecting the steam produced are shown. The amount of steam obtained in this manner is practically enough to supply the power requirements of the plant. Catalyst, cobalt-thoria, is packed between the fins.

Fischer-Tropsch reactors, after an Allied bombing raid, required great skill to repair because they are such complicated equipment.

In Table 1 some of the pertinent operating data and yields for a typical plant are given[5, 6, 7]. Again this is the Meerbeck plant mentioned previously.

TABLE 1.
Operation and yields: Typical German Fischer-Tropsch plant[5, 6, 7].

Operation
65 first stage converters; 35 second stage converters.
100 total converters.
Gas contraction, first stage, 50 per cent.
Overall gas contraction, 75 per cent.
Temperature, 356 to 392°F.
Pressure, 2 lb. per sq. in. ga.
Production (wt. per cent)
Gasoline, 52.2. — Heavy oil, 10.7.
Diesel fuel, 15.8. — Crude wax, 11.3.
Bottled gas, 10.0
Yields
Total plant yield, approximately 1500 bbl. per day.
Gal. per 1000 cu. ft. synthesis gas, 1.16 to 1.6.
Raw materials per 1000 cu. ft. of synthesis gas: 39 lb. o coke, 159 cu. ft. of coke oven gas.

From these data, it is readily seen that German Fischer-Tropsch plants were quite complex and actually made up of many small units. For example, the daily capacity of a single synthesis unit averaged about 15 bbl., which is hardly more than pilot plant size. The plants in general were very sparsely instrumented and necessitated the employment of large operating staffs for hand control.

Such plants were too expensive, complex, and too small in unit size to fit in with American standards of petroleum production. Nevertheless, the alarming predictions concerning the dwindling of petroleum reserves in the United States turned the attention of technical men in this country toward the production of synthetic fuels and in the last few years much of this attention has been focused on the development of modified Fischer-Tropsch processes. It is not my purpose to take a stand on whether U. S. reserves

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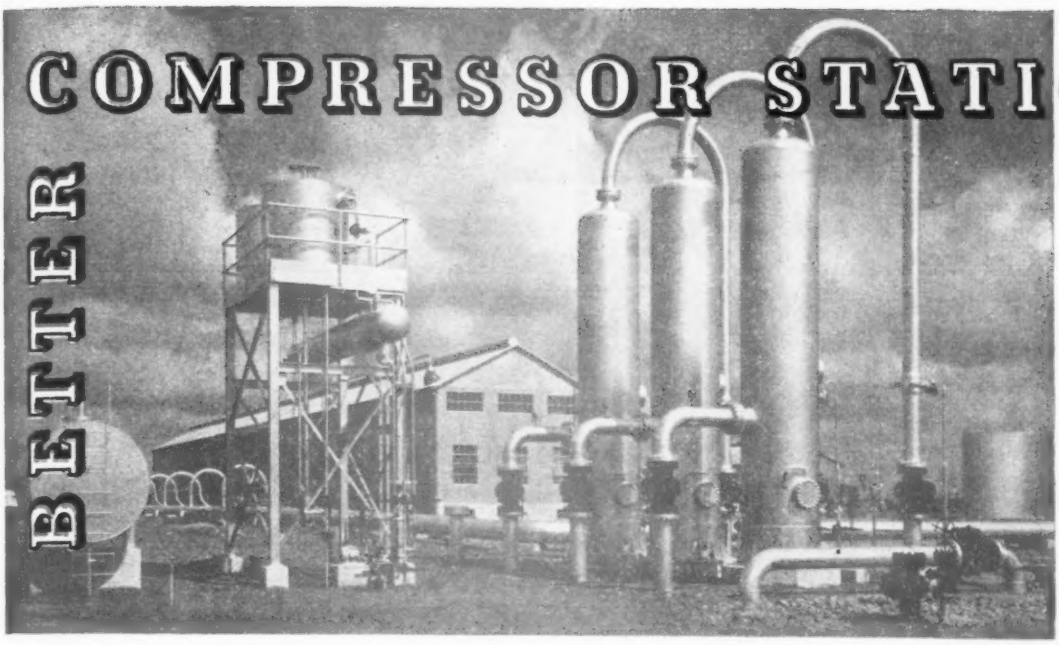

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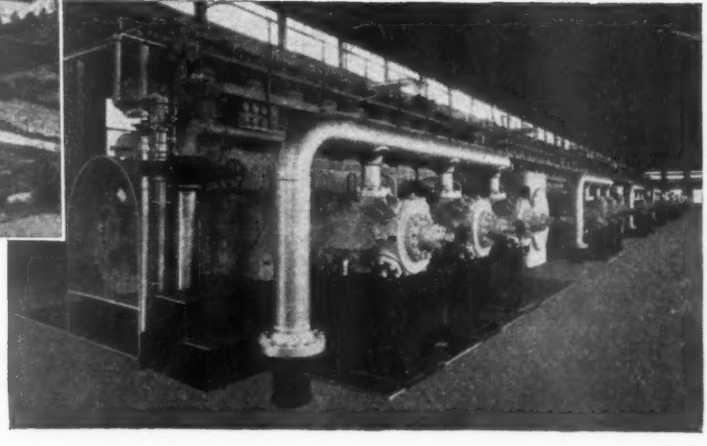

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of petroleum are dwindling at an alarming rate, as some say, or whether this is merely, as others claim, hysteria that is apt to follow any period of excessive consumption. Both opinions appear in the literature. Whether new reserves are located at an increasing or decreasing rate, the alarming predictions have served a good purpose in creating an increased awareness that our petroleum supplies are not inexhaustible and have further led to greater diligence in the search for substitute sources of motor fuel.

During the last few years, progress has been steadily made in the development of these processes, which will compete with crude petroleum as a source of motor fuel. The developments have now reached the point where at least two organizations have announced their intentions to construct plants to produce motor fuel. They are apparently convinced on the basis of extensive pilot plant operation that the process is competitive with crude petroleum. For one of these plants, the Hydrocol, Inc., plant at Brownsville, Texas, the ground will soon be broken. Construction on the Stanolind plant, according to published announcements, is expected to begin within the next two or three years. The optimistic tone with which American versions of the Fischer-Tropsch process are discussed today indicate very strongly that these processes have come a long way from the cumbersome and expensive German process.

Although not many details of the proposed U. S. plants have been made public as yet, it is worthwhile to discuss in a general way some of the major improvements that have been responsible for reducing the cost of gasoline from about 19 cents estimated for the German process down to the estimated 5 cents per gal. on the basis of improved processes.

One of the chief advantages favoring the development of an economic process in the United States depends on the huge reserves of natural gas available. The German process centered on coal as the initial raw material merely because there is scarcely any natural gas at all in Germany. It is definitely cheaper at the present time to produce synthesis gas for subsequent conversion to liquid hydrocarbons from natural gas than from coal. There are several reasons for this. In the first place, the raw material cost of natural gas per barrel of gasoline would probably average somewhat less than that of coal. With natural gas, for example, at 5 cents per 1000 cu. ft. its cost per barrel of gasoline produced (10,500 cu. ft. per bbl.) is approximately 53 cents. To compare favorably with this cost, the price of coal per ton would have to be about 80 cents on the basis of 1360 lb. of coal per bbl. of gasoline produced. With natural gas at 10 cents per 1000 cu. ft., the equivalent price of coal would be $1.60 per ton. Second, gas is simpler and cleaner to handle and therefore less expensive to convert into synthesis gas than coal. A third advantage for natural gas over coal is the greater ease with which desulphurization can be accomplished. Sulphur in coal passes into the synthesis gas and is thence removed. Natural gas representing about one-third of the volume of synthesis gas produced from it can be desulphurized directly in one step to remove hydrogen sulphide. The organic sulphur content of natural gas is usually sufficiently low that its removal can be dispensed with.

FIG. 3. Distribution of proved natural gas reserves.

Another advantage, linked closely with the use of natural gas, is the much larger scale of operations justifiable in the American economy. Savings are effected by the installation of manufacturing facilities of larger capacity.

Before going into a discussion of the improvements that have been made in the production of synthesis gas by the natural gas route it might be well to say a word about the extent of our natural gas reserves as applied to conversion into motor fuel. DeGolyer[8] estimates the U. S. reserves to be about 140 trillion cu. ft. which, on the basis of 4 gal. of gasoline per 1000 cu. ft., represents approximately 13.30 billion bbl. of gasoline. How much of this total reserve gas could actually be utilized economically for the production of motor fuel is a difficult question to answer at the present. At any rate the total available will be considerably less than 140 trillion cu. ft. Some of it will be too sour, some too remote for economical gathering, some too near to centers of population requiring gas for industrial and domestic fuel. The picture is too hazy as yet to hazard a guess. If, however, we assume for purposes of comparison that our petroleum reserves are exhausted and that all this gas will be converted into motor fuel by improved conversion processes, at the rate at which gasoline was consumed, say, in 1940, then these reserves would last conservatively about 15 to 20 years. This is just about the length of time that the experts predict that our oil reserves will last. So if you want to be somewhat optimistic about the conversion of natural gas reserves to motor fuel and slightly pessimistic about our oil reserves, then you could say that the possibility of converting our natural gas reserves to motor fuel just about doubles our potential motor fuel production capacity.

Such gross comparisons, however, are apt to be deceptive. Nobody is going to deliberately set out to build enough hydrocarbon synthesis plants to use up our reserves of natural gas in 15 to 20 years. Such processes, if successful in large scale operations, it is believed, will always be supplemental to some other major source of gasoline. An economic balance between the use of natural gas directly as a fuel and as a raw material for production of gasoline would ultimately be achieved. So, if these processes prove successful, it is believed that there is room for perhaps four or five large scale plants to operate continuously for a much longer period. When the time comes that our natural gas and oil reserves are both depleted, there are enough coal reserves to produce the United States' requirements in motor fuel on the 1940 level of consumption by way of improved conversion processes for the next two to three thousand years. True, the cost of converting coal is greater than the cost of converting natural gas but developments now under way in this country indicate that improvements in the method of producing synthesis gas from coal may reduce the cost to far below those for the German process[9].

In Fig. 3 the geographical distribution of our natural gas reserves are shown.[8] As the amount of natural gas required for a synthetic fuel plant is so great, it is obvious that only a few locations, that is, those fields with large reserves, come into question. A 5000 bbl. per day plant, for example, requires a total of 50 to 70 million cu. ft. of natural gas per day depending upon which published figures are used. Over a period of operation of 20 years this amounts to 365 billion to 510 billion cu. ft. It is not improbable, however, that in the event that synthetic fuel plants prove successful, pipe lines will be laid for considerable distances to bring in gas requirements. The most important fields that come into consideration, as may be seen from the map, are those of western Kan-

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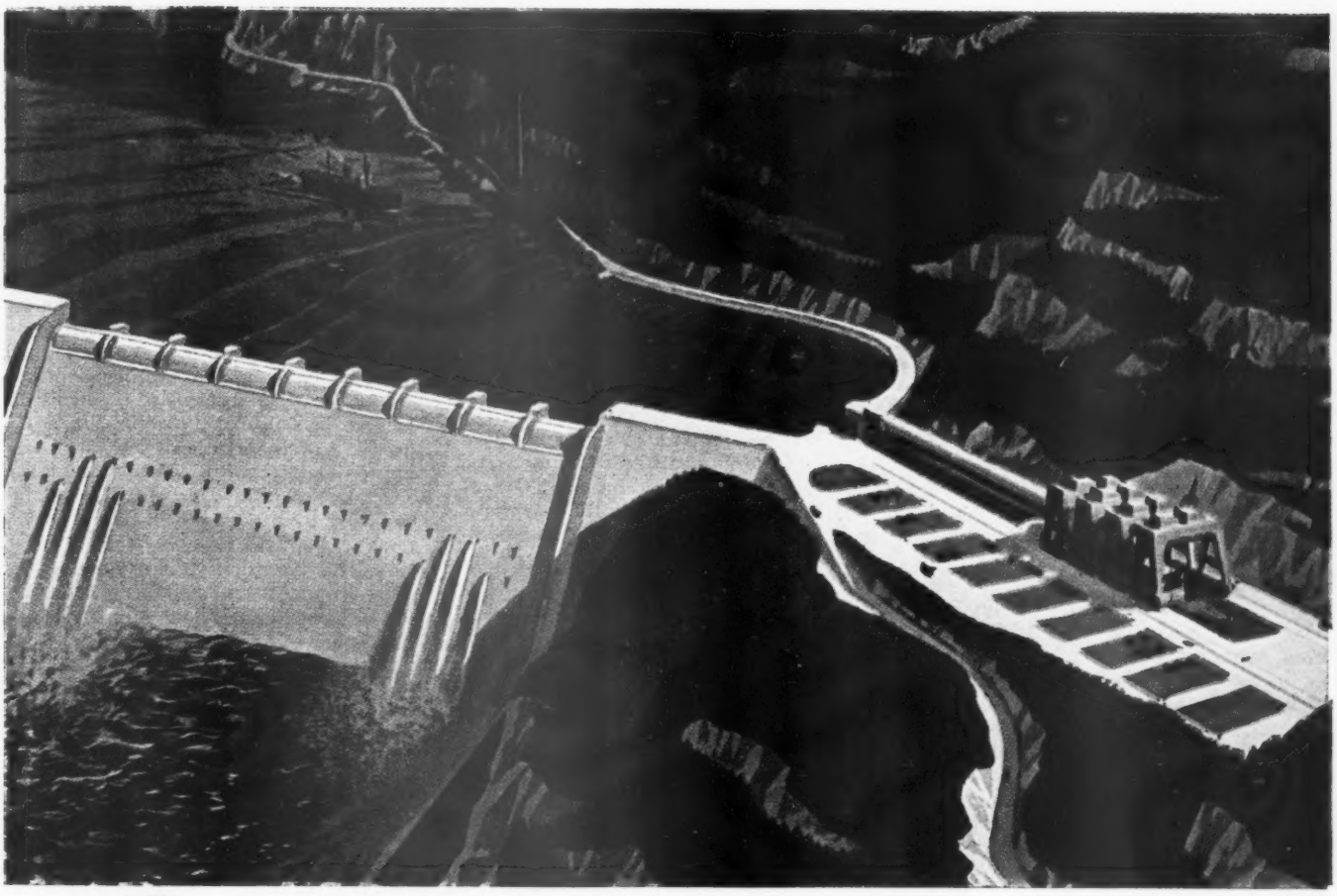

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To sum up the position of natural gas with respect to liquid hydrocarbon synthesis: Natural gas probably will become a supplementary source of motor fuel in the near future and a modest number of plants probably will operate competitively with petroleum. Its use represents an intermediate but important process and as such has greater immediate interest than coal.

And now to leave the field of conjecture and to return to a discussion of the very concrete developments in the conversion of natural gas as liquid fuels, which have given the process a real commercial significance.

Gas, similar to synthesis gas, but containing more hydrogen and less carbon monoxide, has been produced commercially from natural gas and steam in this country for quite a few years. This gas, which contains about 70 per cent hydrogen, 20 per cent carbon monoxide, and 10 per cent of inerts such as carbon dioxide, nitrogen, and residual methane, is currently being used as a source of hydrogen in various industrial processes such as the synthetic ammonia and methanol processes and the hydrogenation of petroleum stocks. The carbon monoxide is oxidized in a subsequent step to carbon dioxide, which is scrubbed out, leaving substantially pure hydrogen. The gas is produced in multi-tube gas fired reactors, each tube being about 3 in. in internal diameter and filled with nickel catalyst. These units operate at about 1600° F. and, therefore, the tubes are made of expensive alloy steel. Tubes of small diameter are used in order to supply easily the heat required to maintain reaction temperatures, for the reaction is highly endothermic. This process can be modified to produce synthesis gas having a ratio of hydrogen to carbon monoxide of 2:1 by introducing carbon dioxide as well as steam and natural gas into the conversion unit. The combined reaction may be represented as the sum of two separate reactions as shown:

$$2\,CH_4 + 2H_2O \rightarrow 6H_2 + 2CO$$
$$CH_4 + CO_2 \rightarrow 2H_2 + 2CO$$
$$3CH_4 + 2H_2O + CO_2 \rightarrow 8H_2 + 4CO$$

This method of operation for synthesis gas production with multi-tube reactors is relatively costly but has found considerable commercial application where the final product sells, such as synthetic ammonia, for a fairly good price, or where the amount of gas required per unit of finished product is relatively small, such as in the case of hydrogenation of petroleum stocks. But for the process of producing motor fuel directly from such gas, in which case about 30,000 cu. ft. of synthesis gas per barrel of product are required, the cost is high.

One alternative method for making synthesis gas, which is now being used in pilot plant operation in this country, depends on the use of pure oxygen. Before the war, the idea of using pure oxygen in large quantities for industrial purposes was wishful thinking. The cost was far too great. During the war, however, at least two improved low-temperature fractionation processes for obtaining oxygen from air were developed. The improvements are chiefly concerned with higher thermodynamic efficiencies in low pressure operation of adiabatic expansion engines. Used in conjunction with a synthetic fuel plant the cost of oxygen is now said to be as low as 5 cents per 1000 cu. ft. This figure includes practically no power costs, for sufficient power, as will be discussed later, is obtained by production of steam in the hydrocarbon synthesis step.

The production of synthesis gas from natural gas and oxygen can be represented by the following equation:

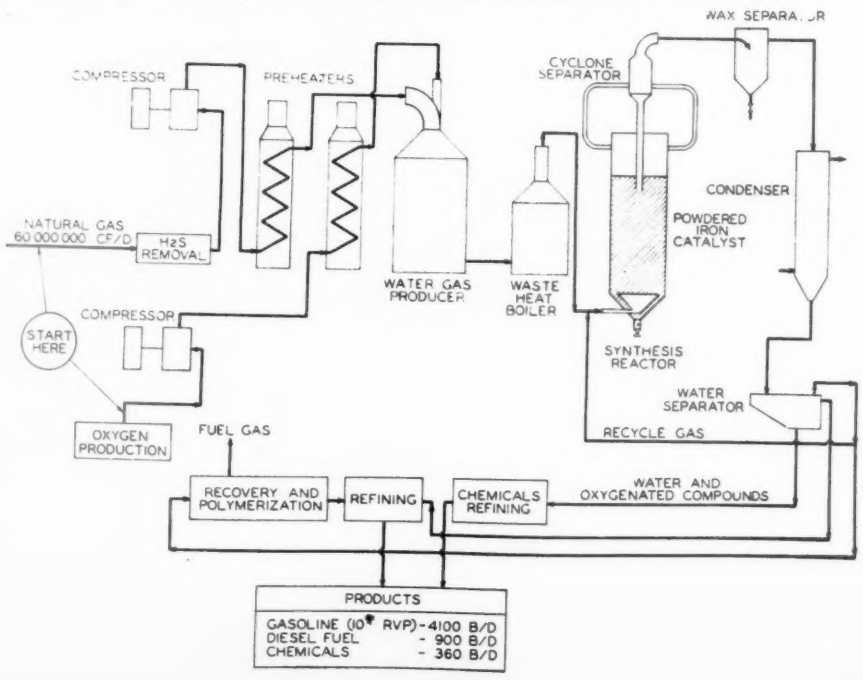
$$CH_4 + \tfrac{1}{2}\,O_2 \rightarrow CO + 2H_2$$

The theoretical amount of oxygen required is seen to be one-half the volume of methane. The reaction temperature is high, about 2100° F.; but the reaction has one decided advantage over the carbon dioxide-steam-natural gas reaction, previously mentioned, namely that it is exothermic instead of endothermic and, therefore, once the reactants are preheated to temperatures considerably below reaction temperature the reaction commences and supplies its own heat to bring the temperature up. Small diameter reaction tubes are not necessary in this process; the reaction proceeds in specially designed large diameter reactors. A nickel catalyst may be used, if desired, to promote the reaction, the reaction will take place without catalysts. The reaction may be conducted at atmospheric pressure or at higher pressures. It is desirable to operate at a pressure equal to that employed in the subsequent synthesis step (150-250 lb. per sq. in.) in order to eliminate compression of the synthesis gas, which is approximately twice the volume of the reactants. Natural gas usually can be supplied from pressure distillate operations without the necessity for compression. This leaves only the oxygen, which must be compressed as it comes from the low temperature unit at approximately atmospheric pressure.

Although there is not much information available for publication at present on other cheap processes for the production of synthesis gas, the method involving the use of carbon dioxide, steam, and methane, as previously mentioned, certainly has not reached its ultimate stage of development. The improvement to be anticipated here is to carry on the reaction in large diameter reactors instead of in multi-tube reactors with provisions for overcoming the endothermic nature of the reaction.

The only major improvement made on the process in this country is also indirectly a war baby. It involves the use of a fluid catalyst in the synthesis of hydrocarbons from synthesis or water gas. The use of fluid catalysts was developed on a tremendous scale during the war in conjunction with petroleum cracking. The fluid catalyst technique has been described many times in the literature. Essentially it consists in introducing the gaseous or vaporized feed into the bottom of the reaction chamber filled with catalyst sufficiently fine to be suspended or fluidized in the vapor stream. The reaction takes place in the swirling, turbulent mixture of catalyst powder, products, and reactants. Catalyst dust is removed from the gaseous effluent by cyclone separators in the top of the reactor. Electric precipators frequently are used beyond this point to remove the last, persistent traces of dust. If the catalyst requires regeneration, it may be removed from the reactor continuously and carried by the regeneration gas into a regenerator working on the same principle as the reactor. If the

FIG. 4. Flow diagram of the conversion of natural gas to motor fuel.



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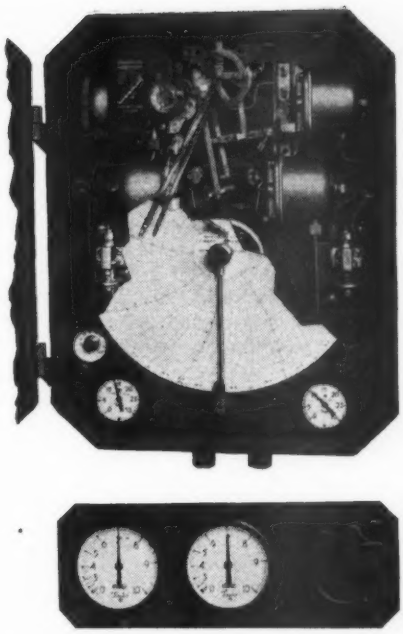

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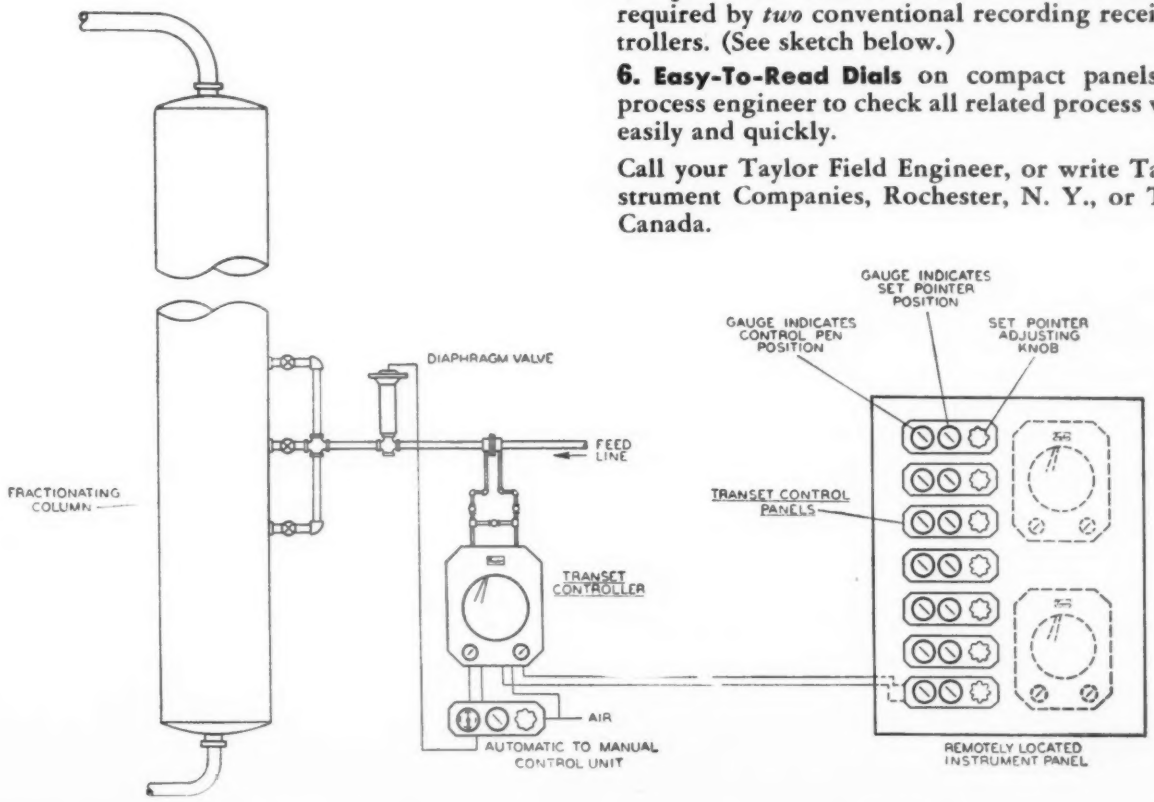

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catalyst does not require frequent reactivations, it is allowed to remain in the reactor indefinitely and such a process is commonly referred to as fluidized fixed bed operation.

Although there is still room for improvements and possibilities in fixed bed operation, for the synthesis of hydrocarbons from water gas, fluid-type operation has special significance. In the first place, the finely divided catalyst presents a greater amount of easily accessible surface. Thus the reaction proceeds faster. For example, in the standard German type of operation granular or pelleted catalyst the speed velocities in volumes of fresh food per volume of catalyst per hour vary from about 100 to 250 whereas in fluid type operation with iron catalysts space velocities between 2000 and 3000 may be used.

Second, the use of fluid catalysts simplifies the problem of heat removal. We have mentioned previously the very high heat of reaction that attends the formation of hydrocarbons from water gas. The average reaction heat amounts to about 7000 B.t.u. per lb. of product formed.

In conventional fixed bed reaction using granular or pelleted catalyst, the maximum allowable distance of separation between catalyst and cooling surface for efficient heat removal lies between $\frac{3}{8}$ and $\frac{1}{4}$ in. Furthermore, the cooling surface in this case must be within a few degrees of the reaction temperature in order to prevent the existence of temperature gradients across the bed. In fluid operation not only is the allowable reaction rate 10-20 fold greater than in fixed bed operation, but much greater distances of separation of catalyst and gases maintain a uniform temperature within the reaction even at a large temperature differential between the cooling surface and catalyst.

Details of reactor design are not available for publication at the present time. Several designs look promising. In general, it may be stated that the heat of reaction will be dissipated either as sensible heat on the catalyst, which may then be cooled by recirculation outside of the reaction zone, or by the production of steam in water-cooled tubes extending vertically into the reaction zone.

Having described briefly the major improvements that American research has contributed to the original Fischer-Tropsch process, it might be well to piece them together into a simplified flow diagram in order to illustrate how the process may work on a commercial scale. Looking at the diagram in Fig. 4, desulphurized natural gas and oxygen are preheated separately and passed into a combustion reactor where synthesis gas consisting of two parts of hydrogen to one part of carbon monoxide is produced. The exit gas is cooled from about 2100°F. down to 600°F. in a waste heat boiler where a portion of the power requirements of the plant as steam is produced. The gas at about 600°F. is now passed into the synthesis reactor where liquid hydrocarbon product is formed. Here the reaction occurs in the presence of powdered iron catalyst in a fluidized state. The reaction temperature is controlled by water-cooled tubes extending into the reactor. Tremendous quantities of steam are thus produced for use as power throughout the plant. The plant as a whole is practically self-sufficient in power. The effluent gases and vapors, separated from catalyst particles, pass in succession through a wax trap, condenser, and accumulator. The product in the accumulator separates into a water phase and a hydrocarbon phase. The water phase is drawn off and oxygenated compounds, predominantly ethyl or more familiarly grain alcohol, removed. The hydrocarbon layer passes on to refining into diesel fuel and motor fuel. By mild refining such as treatment at relatively low temperature over bauxite the raw gasoline will have about a 75-80 octane number. The cetane number of the diesel fuel is over 50.

From 60 million cu. ft. of natural gas the yield is estimated to be approximately 5000 bbl. of total refined hydrocarbon product consisting of about 4100 bbl. of motor fuel and 900 bbl. of diesel fuel. These are average figures based on various reports in the literature. In addition, about 360 bbl. of oxygenated products are produced chiefly grain alcohol.

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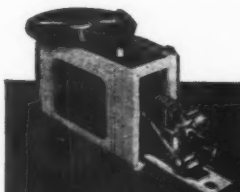

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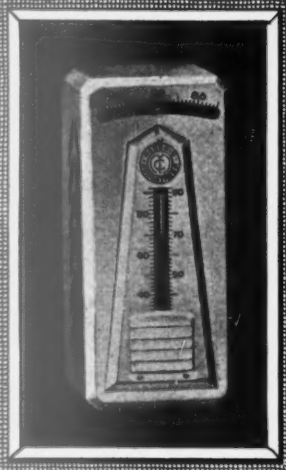

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ments than to give the estimated investment and production costs of the American and European processes. In Table 2 these comparisons are given.

TABLE 2. Comparative cost for production of liquid fuels: European and American Processes [9, 10].

	Investment cost, per bbl. per day	Cost per gal. (including 10 per cent depreciation)
European process using coal	$7600	19.2 cents*
European process using natural gas	$4750	8.8 cents†
American process using natural gas	$2000–2500	Approx. 5.0 cents†

*Coal at $2.75 per ton.
†Natural gas at 5 cents per 1000 cu. ft.

In conclusion, the engineering improvements that have been made on this process and which have contributed to its potential, large-scale success in this country are:

(1) Improvements in synthesis gas production, particularly the utilization of oxygen.

(2) The use of fluidized catalyst technique in the synthesis step, thus increasing throughputs and solving the problem of dissipation of the heat of reaction.

In addition, this country possesses certain economic advantages favorable to this process:

(1) Large natural gas reserves, which are more suitable at present than coal as a raw material.

(2) The larger scale of operations, justifiable in the American economy, which result in savings from the use of manufacturing facilities of larger capacity.

As for the future of plants for conversion of natural gas to liquid fuels, there is every reason to believe that within the next five years several commercial units will be in operation. Being a new process, many unanticipated difficulties will be encountered during the initial months of operation of these plants, but none of these difficulties is expected to be insurmountable.

Further improvements, particularly with respect to yields of liquid hydrocarbon products, undoubtedly will be made, reducing the quantity of natural gas required per gallon of product. In the meantime, one can also expect further improvements in the use of coal in this process, so that in the next ten years or so it may become competitive too.

1. U. S. Strategic Bombing Survey, Oil Division, Final Report, p. 1.
2. Ibid, p. 18.
3. Ibid, Fig. 15.
4. Ibid, Fig. 98.
5. Ibid, p. 88.
6. T.A.C. Report SnMC-1, p. 17.
7. T.A.C. Report SnMC-2, p. 24.
8. "Estimate of U. S. Gas Reserves." Statement of E. DeGolyer to Senate Committee on Investigation of Petroleum in Relation to National Welfare, Washington, D. C.
9. "Gasoline from Natural Gas," P. C. Keith, *Oil and Gas Journal*, May 18, 1946.
10. "Synthetic Liquid Fuels." Hearings before a Subcommittee on public lands and Surveys, United States Senate, Seventy-Eighth Congress, First Session on S. 1243, U. S. G.P.O., Washington, D. C., 1944. ★ ★ ★

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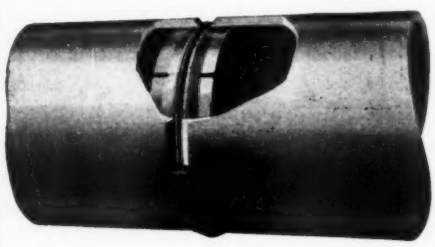

line. Wedge SPLIT Chill Rings fit snugly on the unfinished inside pipe surface, because of their exclusive flexible feature. Alignment is simplified and speeded up. Welders work faster, and you are sure of 100% penetration of every joint. Why not investigate this NEW and BETTER way of welding pipe?

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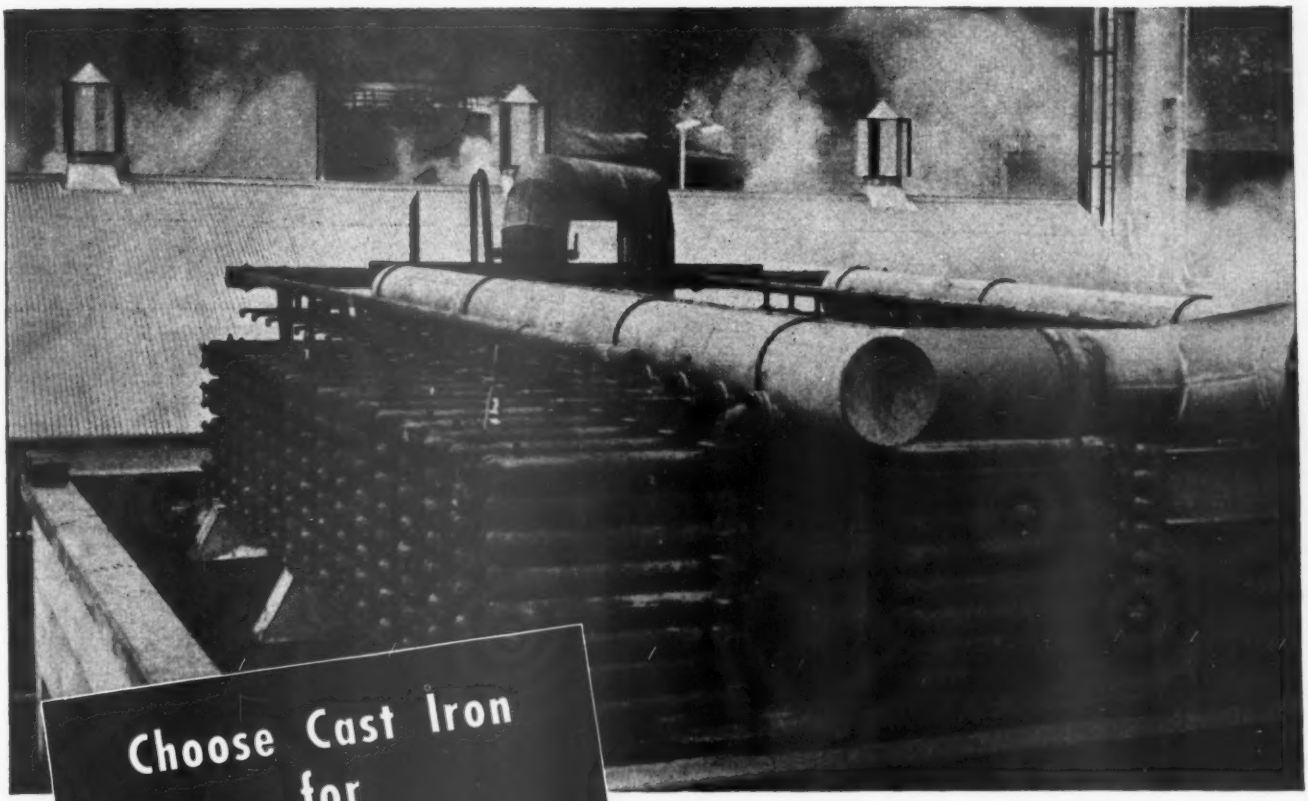

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The petroleum engineer as a supervisor*

By **THOMAS C. FRICK,** Atlantic Refining Company

AFTER receiving his degree the petroleum engineer generally starts to work for an oil company or for an oil field service company in the oil field and receives industrial training that will acquaint him with producing and drilling problems. At this point the young petroleum engineer needs to remind himself that a degree does not entitle a man to professional consideration; the graduate is a novice with his professional spurs yet to be won. The period of industrial training varies from company to company but the usual minimum is one year and the maximum three years. Working as a roustabout, lease pumper, driller's helper, laboratory assistant, and at other jobs the young engineer becomes familiar with practical oil field problems. This training period is just as important to the petroleum engineer as an internship in a hospital is to a young medical doctor, because the engineer uses and sees tools and machinery that are used to drill wells and produce oil.

The next logical step in the professional development of the petroleum engineer in the oil industry is to the position of junior engineer, or equivalent. Working under experienced engineers the junior engineer becomes familiar with company engineering policies and procedures. Tests, field problems, collection of data, computations, and preparation of reports go to make up his job. From this point the professional advancement of the engineer depends on his individual abilities and interests, and the opportunities afforded him by his employer. Fig. 1 shows how the petroleum engineer might advance professionally into scientific and supervisory fields of the petroleum industry. As the petroleum engineer advances in his profession, regardless of the type of work, there is some point along the line where he probably will become a supervisor. As a supervisor a new tool is placed in his hands — manpower, and new skills must be acquired to use this important tool.

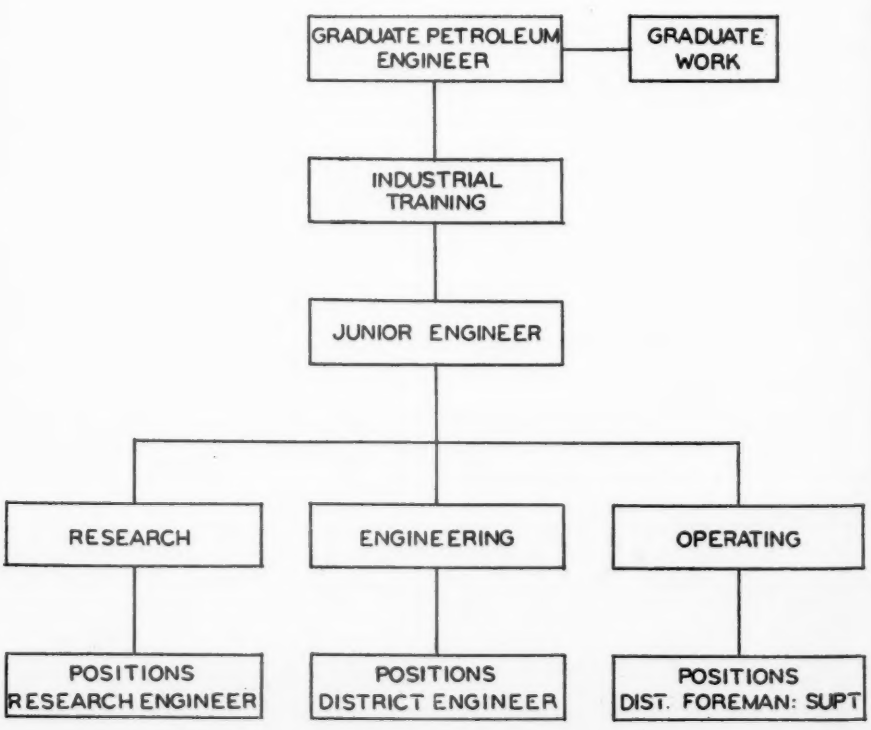
Through training and natural interest the petroleum engineer is concerned about machinery, structures, oil reservoirs, etc. In other words the engineer is naturally interested in "things," but professional advancement brings about supervisory duties and the engineer must be prepared to deal with "men and their ways," no less than "things and their forces." Supervisory positions bring opportunities to advance in the field of management and the broader field of management offers greater financial oportunities for engineers. For top management positions the one most important qualification, in addition to engineering knowledge and skill, is the ability to get along with and direct the work of others.

Occasionally, petroleum engineers promoted to supervisory positions delight in casting off their engineering cloaks and boasting that they are no longer engineers but that they can handle all problems. Such men were either poor engineers to begin with or have not been able to keep abreast of petroleum engineering developments nor acquire the skills that a supervisor must possess. Every supervisor has five fundamental responsibilities in carrying out his duties; a supervisor is responsible for equipment, costs, methods, men, and policy. Problems involving equipment costs, and methods are familiar to the petroleum engineer because he has been trained to work with these items. Problems involving men and policy are strange to the petroleum engineer so he must train himself to handle these problems in order to become a good supervisor.

Good supervisors have also realized that they have at least five needs. These five needs are: (1) Knowledge of work; (2) knowledge of responsibilities; (3) skill in instructing; (4) skill in improving methods, and (5) skill in leading. The petroleum engineer will have some of these needs but more often than not he will have very little skill in leading at the time he receives his first supervisory assignment. Skill in leading helps the supervisor to improve his ability in working with and directing the activities of others. Skill in leading can only be acquired through practice and is that skill that a supervisor must possess to handle human relations problems.

The War Manpower Commission developed a job relations training program during the war to improve supervision in war industries. Figs. 2 and 3 are outlines of the fundamentals of job relations and how to handle human relations problems, respectively, that were developed by the Training in War Industry Branch of the War Manpower Commission.

FIG. 1



*Presented at joint meeting, Texas sections, American Institute of Mining and Metallurgical Engineers, Petroleum Division, at University of Texas, Austin, December 18 and 19, 1946.

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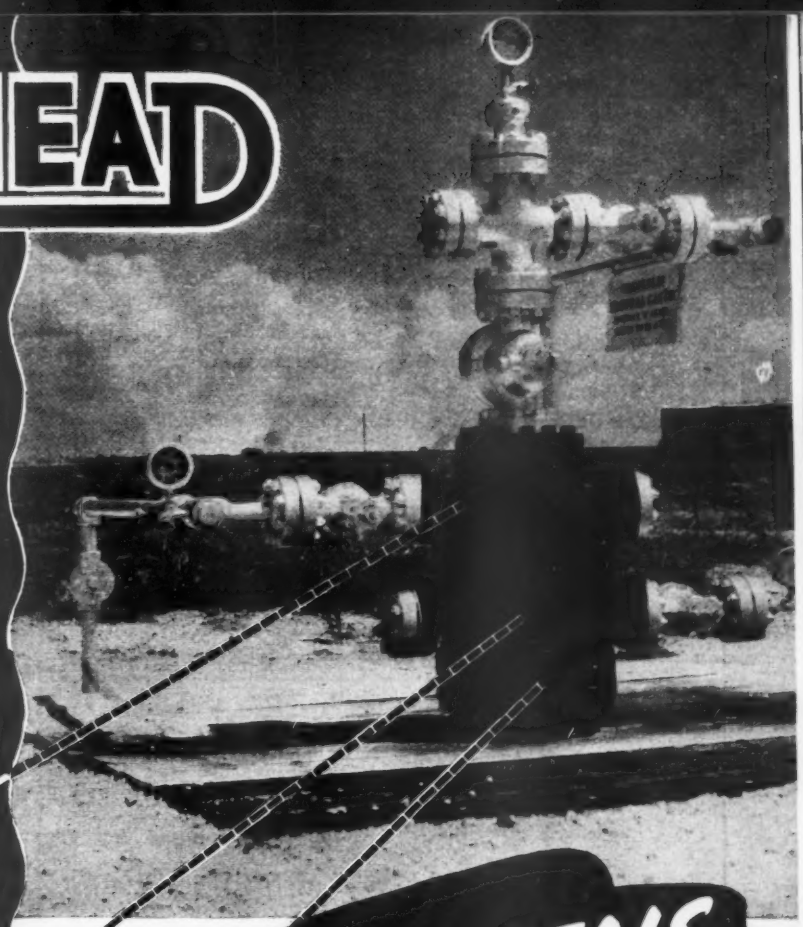

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FIG. 2

Job relations

A SUPERVISOR GETS RESULTS THROUGH PEOPLE

Let each worker know how he is getting along.
Figure out what you expect of him.
Point out ways to improve.

Give credit when due.
Look for extra or unusual performance.
Tell him while "it's hot."

Tell people in advance about changes that will affect them.
Tell them WHY if possible.
Get them to accept the change.

Make best use of each person's ability.
Look for ability not now being used.
Never stand in a man's way.

PEOPLE MUST BE TREATED AS INDIVIDUALS

FIG. 4

HUMAN RELATIONS PROBLEMS	ENGINEERING PROBLEMS
1. What are the objectives?	1. What is the job?
2. What are the facts?	2. What are the data?
3. What possible actions can you take?	3. What alternative methods should you consider?
4. Did you meet your objective?	4. Did you get the job done?

FIG. 3

How to handle a human relations problems

1—GET THE FACTS
Review the record.
Find out what rules and customs apply.
Talk with individuals concerned.
Get opinions and feelings.
Be sure you have the whole story.

2—WEIGH AND DECIDE
Fit the facts together.
Consider their bearing on each other.
Check practices and policies.
What possible actions are there?
Consider effect on individual, group and production.
Don't jump at conclusions.

3—TAKE ACTION
Are you going to handle this yourself?
Do you need help in handling?
Should you refer this to your supervisor?
Watch the timing of your action.
Don't pass the buck.

4—CHECK RESULTS
How soon will you follow up?
How often will you need to check?
Watch for changes in output, attitudes, and relationships.
Did you meet your objective?

Supplementing Fig. 3 in handling human relations problems to get the facts, review the individual's record and include all that you know about the individual. When finding out what rules and customs apply, remember that there are written and unwritten rules. Talk to the individuals concerned and get their opinions and feelings. Remember that what a person thinks, right or wrong, is a fact to him and must be considered as such. It is a fact that an imaginary grievance can be just as important to an individual as a real grievance. Review the facts and make sure that you have the whole story.

In weighing the facts and making a decision look for gaps and contradictions when fitting the facts together. Consider the bearing of facts on each other and never overlook an individual's good points in favor of his bad points. There is usually more than one possible action to be taken if we weigh all the facts. A supervisor should know whether his action is within company policies and industry practices. Consider objectives and consider the effect of the action on the individual, on the other people and on production. A supervisor should never jump at conclusions.

When taking action on a human relations problem, decide whether you are going to handle the problem or whether as a supervisor you need help from the personnel department or other departments. If the problem is beyond your authority for action, refer it to your supervisor with recommendations. In any case the timing of your action greatly influences the effectiveness of your action. Don't pass the buck—it weakens you as a supervisor.

Check the results of your action just as you would check to make sure that equipment has been installed properly. Make your first check as soon as you can reasonably expect results. Make sure that your action hasn't created another problem and watch for changes in the individual's or group's attitude and output. Did your action help production?

The logic behind the outline in Fig. 3 is similar to the procedure of solving any engineering problem. Fig. 4 shows a comparison of handling human relations problems and engineering problems. The logic is identical.

The petroleum engineer can and does develop into a very good supervisor, which gives him an opportunity to reach top management positions, but as a supervisor he must realize at all times that people must be treated as individuals and that human relations problems should be solved in a logical manner.

Oil for China

Oil for China and the Philippines will be supplied by private companies soon, marking the restoration of another link in the civilian economy of the Far East.

After the war, the army and navy distributed limited quantities of oil, kerosene, gasoline and other petroleum products for civilian needs. Later, the army and navy helped American companies get back into business by renting them storage space and supplying oil from military stocks.

After December 31, in the China coast area, and after January 31 in the Philippines, private companies will be on their own, the Army-Navy Petroleum Board announced.

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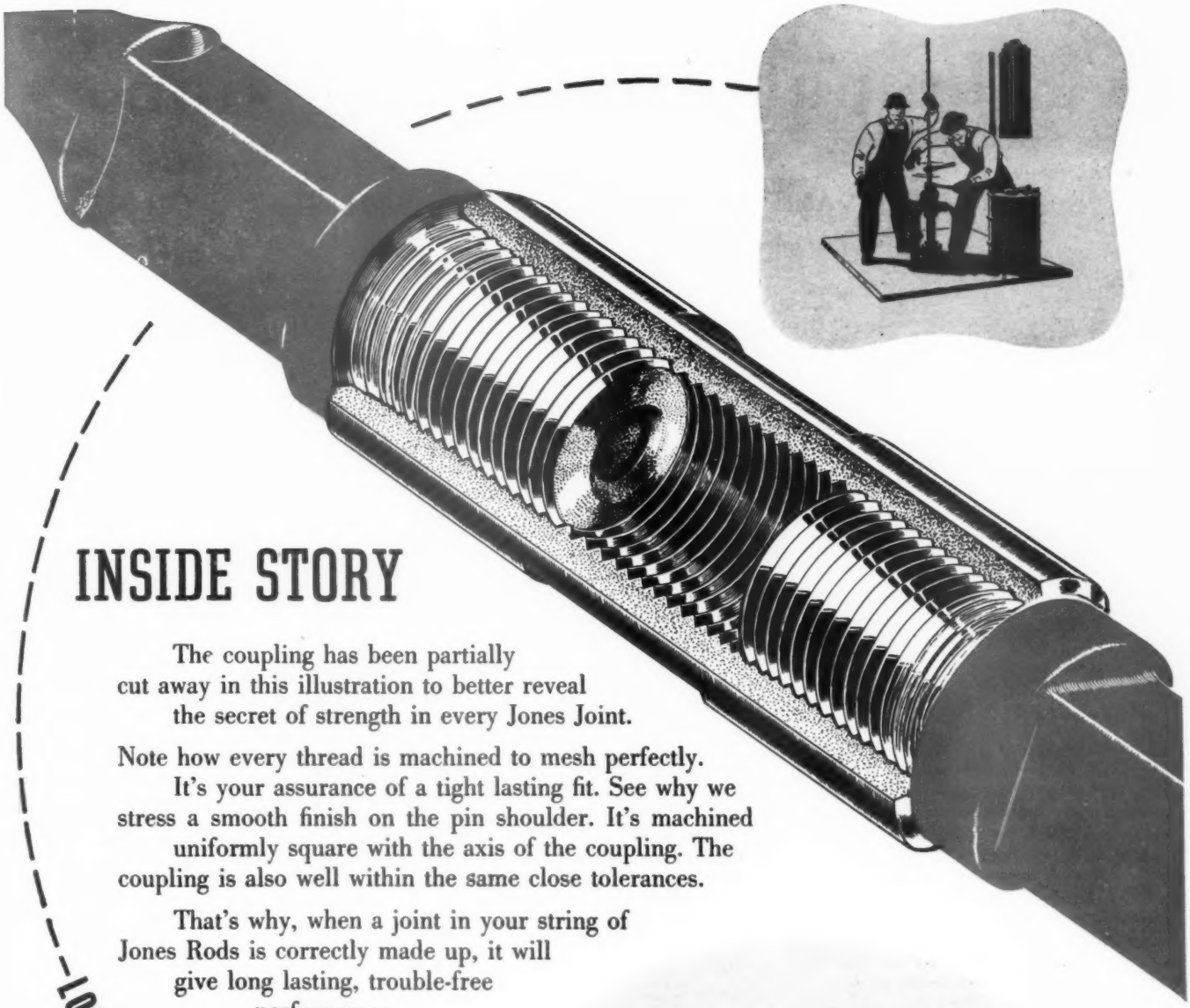

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The pattern for decision

By **E. DANIEL HAYWARD,** *Vice President and Director,*
Production Management Engineering Associates, Inc.

EDITOR'S NOTE: *Material used in this article on the important problem of reducing maintenance and repair costs, has been obtained from actual industrial accomplishments performed by Production Management Engineering Associates, Inc.*

E. D. Hayward

During its 30 years' experience in the field of industrial engineering, this West Coast firm has originated and developed many practices and principles in the field of industrial production and maintenance. Among other accomplishments it has pioneered in the perfection of time study techniques; developed the use of standard data for repetitive production operations and for non-repetitive maintenance and jobbing work; and developed improved means for the use of motion pictures in industrial studies, method improvements, and job training.

There is certainly an ever-expanding pattern of successful and progressive endeavor in the field of industrial engineering that American business men will do well to consider in respect to their pursuit of increased productivity at lower costs and in their quest for better labor relations.

WHAT is it that makes a decision a welcome, satisfying answer to a problem, whether it be a complex technical problem or a simple everyday request for guidance?

EXCLUSIVE

The acceptable decision or direction must have as its basis the most complete understanding, knowledge, and comprehension of all sides of the problem that the foreman, supervisor, manager, or executive can give to it. A quick answer, based on overall judgment, may settle the simple question, but as the problem becomes more complex, and the variations more numerous the understanding answer must have more and more of the cold factual background of thorough analysis and less and less of the element of snap judgment.

● **Production control a "must."** You may say that this is an abstract principle of purely academic interest; but if you will look closely, its application can be found in almost every business, industry, or operation where labor is involved.

The larger the organization, the more decisions and directions are needed and the more care is required to keep the pattern for decision consistent and comprehensive.

As an operation grows from a "one man shop" to a full-sized organization with workers, foremen, superintendents, and managers, involving a variety of skills and a complexity of process, production control becomes a "must." The principles already stated become a matter of daily concern.

When the mechanical equipment has developed into a maze of motors, machines, conveyors, pipelines, tanks, pumps, vessels, and power plants, you have a maintenance problem, which to many industries constitutes a major item in the cost of operation.

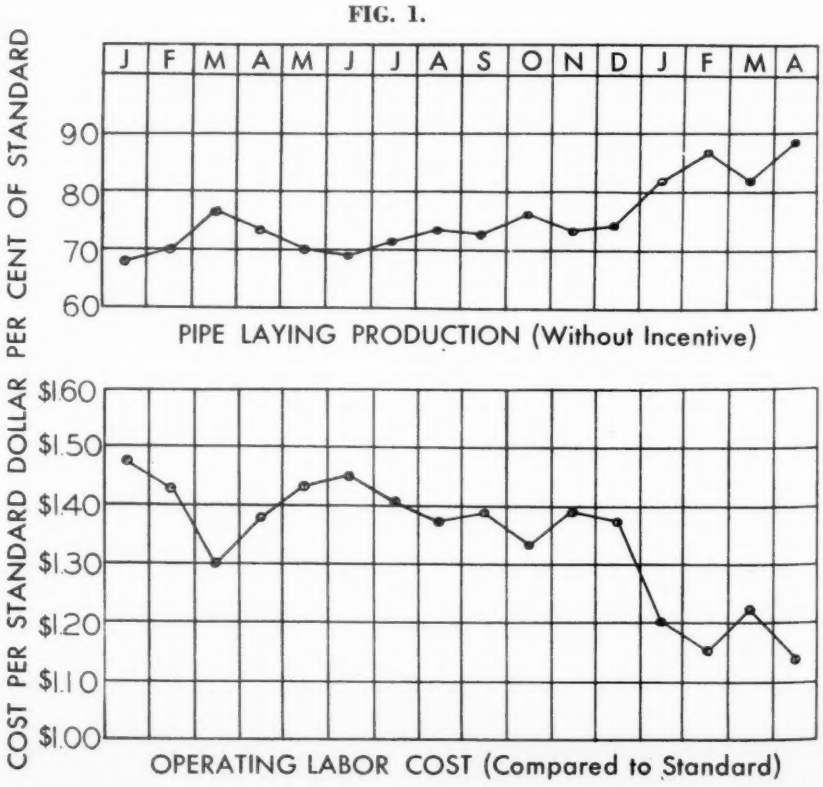
● **Effective work required.** The steel mill, the refinery, the cannery, the heavy construction industry, the lumber industry, and others, experience a maintenance problem involving many crews, many skills, and a substantial payroll.

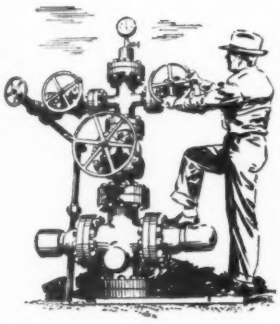
The control of these crews is important in itself. More important is the fact that their effective functioning is the very life blood of the plant. The minute a piece of equipment fails, the idle man-hours begin to accumulate at an alarming rate; the dollars start rolling down the "sewer" to the sea . . . all labor dollars, overhead dollars, and profit dollars.

Of course, that does not mean your plant. You have skilled mechanics, electricians, millwrights, pipe fitters, blacksmiths, painters, carpenters, and helpers to repair and maintain your equipment and avoid as much down time as possible. But is this service good enough? How much money could you save if you paid as much attention to this phase of your operations as you do to processing your product?

● **Cost control overlooked.** Most operators hire the most skilled mechanics obtainable, provide a good supply of necessary tools, lay out a program of inspection and repair, and have good foremen to assign the men and supervise the more difficult jobs; but in our many years spent in working with industrial plants, far too few cases have been found where

FIG. 1.





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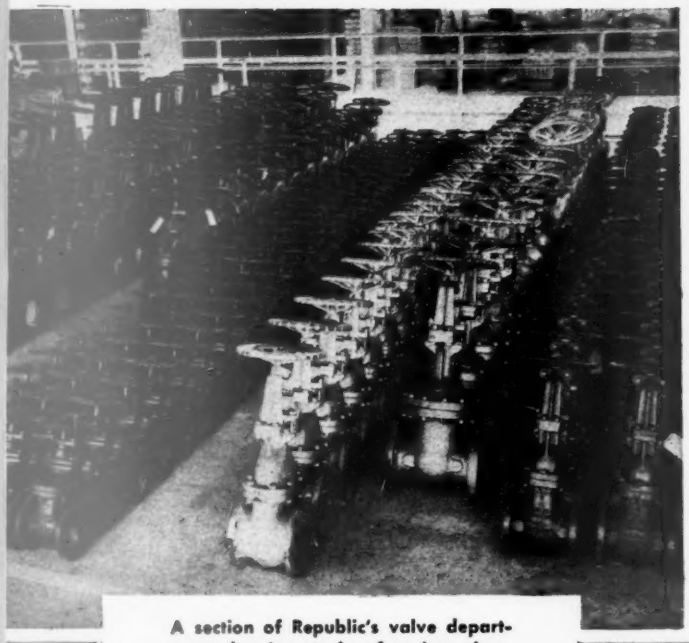
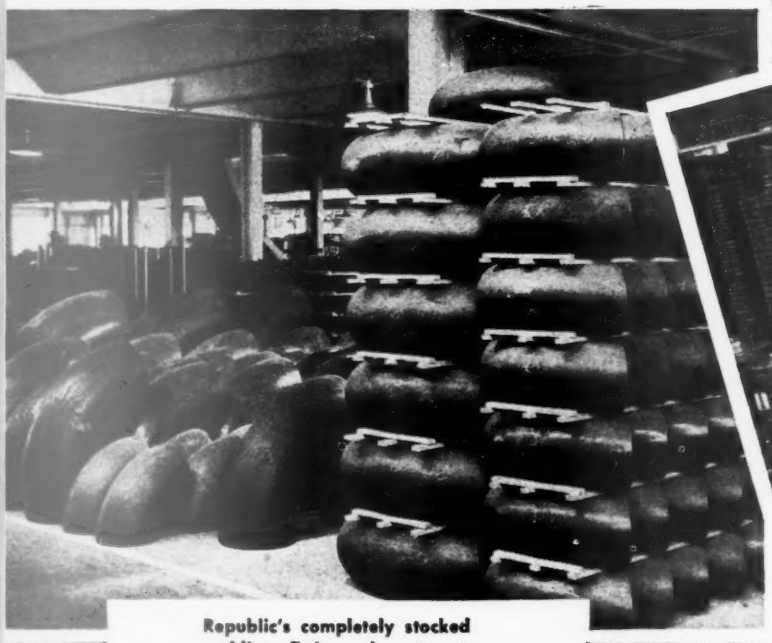
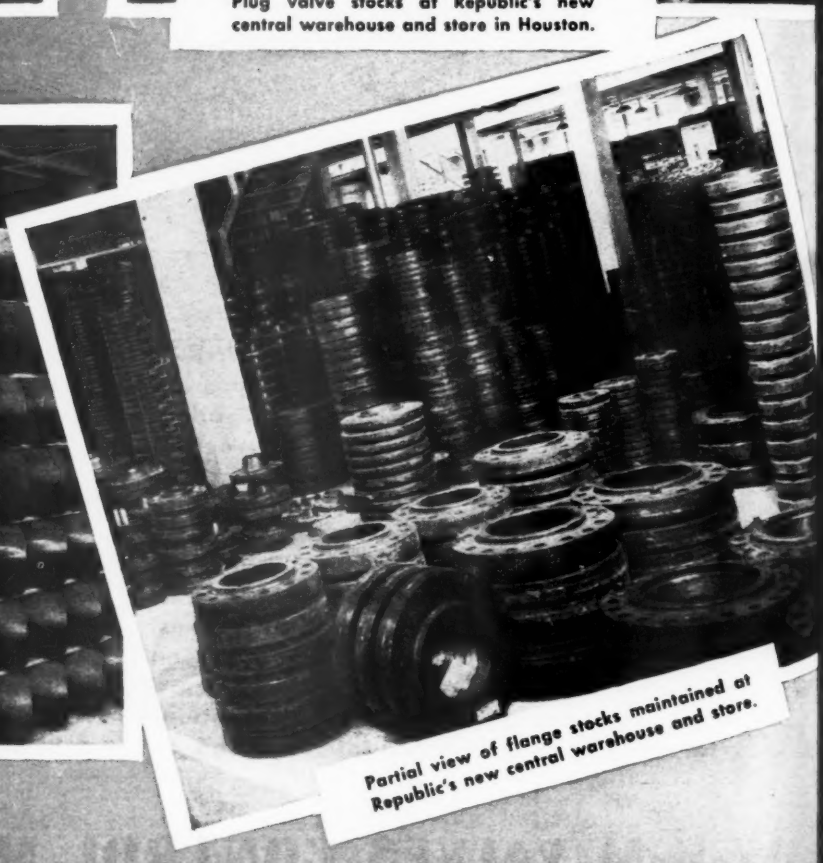


A section of Republic's valve department showing stocks of various sizes.

Plug valve stocks at Republic's new central warehouse and store in Houston.



Republic's completely stocked welding fittings department.



Partial view of flange stocks maintained at Republic's new central warehouse and store.

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* District offices and stores. † Sales Office.

ERY *Warehousing*

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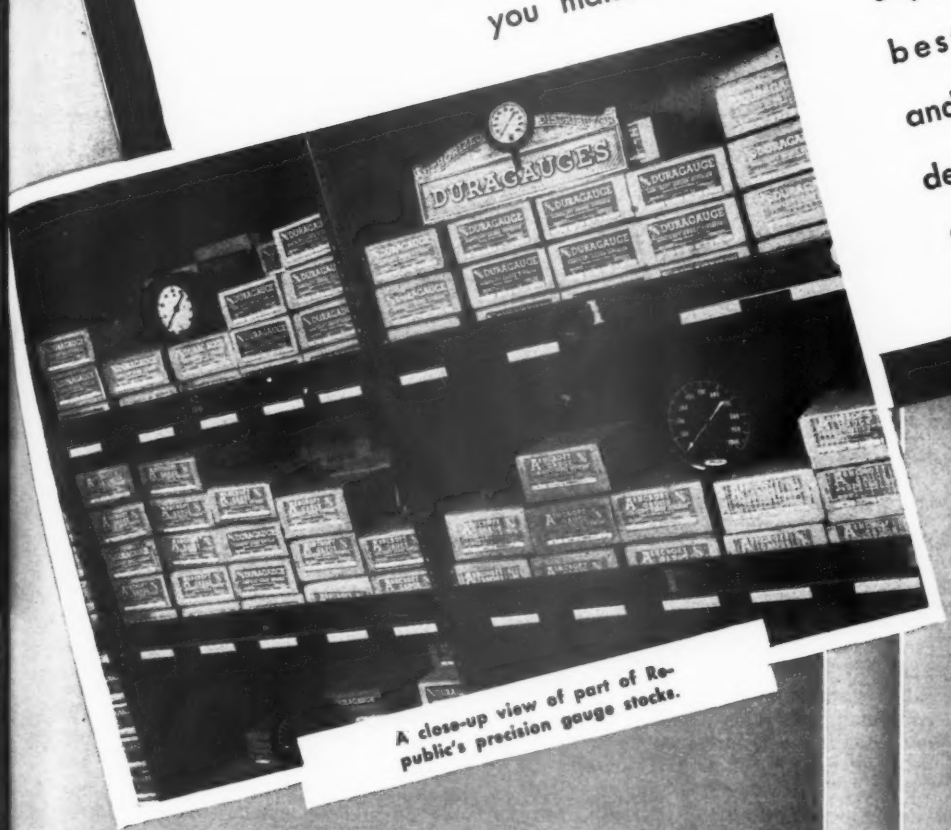

A close-up view of part of Republic's precision gauge stocks.

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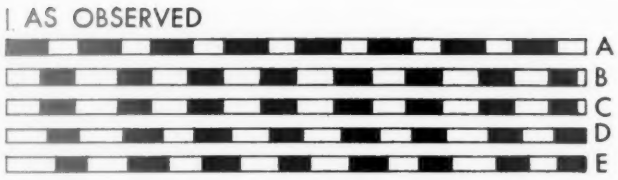
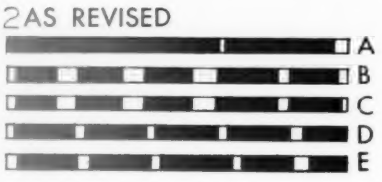




MAN MINUTES

1. AS OBSERVED

WORK	WAIT	TOTAL	OPER.
280	220	500	A
235	265	500	B
235	265	500	C
228	272	500	D
228	272	500	E
1206	1294	2500	

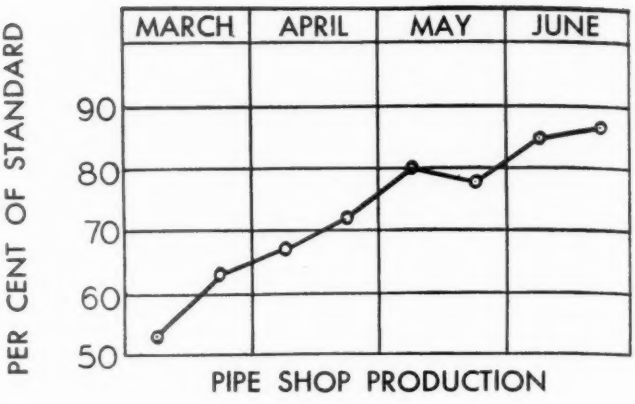
2. AS REVISED

280	15	295	A
235	60	295	B
235	60	295	C
228	67	295	D
228	67	295	E
1206	269	1475	

MAN HOURS

UTILIZED	
20.1	
LOST	
21.6	
PAID FOR	
41.7	
UTILIZED	
20.1	
LOST	
4.5	
PAID FOR	
24.6	

FIG. 2. Coating pipe in trench.



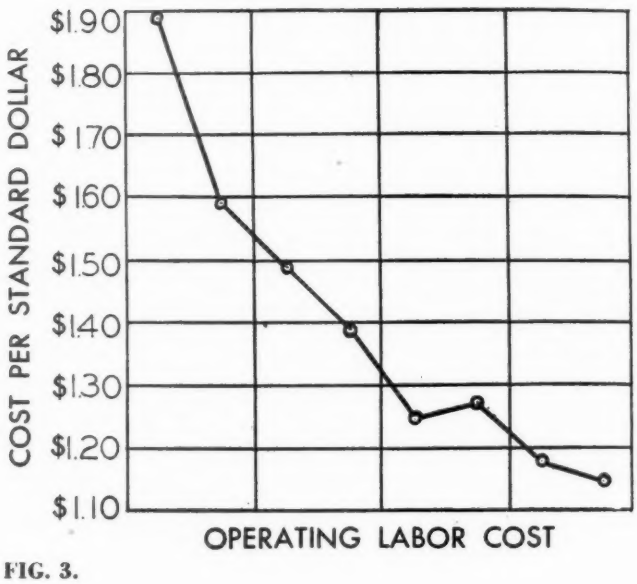


FIG. 3.

management had given as much consideration to careful thought, cost analysis, and planning of plant operation as it did to the more outwardly apparent problems of materials, production, and sales.

● **Cost fluctuation studied.** Fig. 1 illustrates an actual example of accomplishment, resulting from job analysis, methods study, and a development program conducted by supervisors and workmen to encourage cost consciousness and an appreciation of what causes fluctuating operating costs. This record covers a department of small crews working at many different locations on the installation, layout revision, and maintenance of underground pipe lines.

Job analysis and time measurement established basic time standards on each element of the work on each skill involved. No two jobs were alike, but every job required a determinable amount of the excavation, welding, pipe fitting, and backfilling elements for which practical time standards had been established. The calculations of the manhour work content of each individual job was reduced to the simplest possible form, and was made at a cost of 3 to 4 per cent of the labor hours involved. No incentive payments to workers were involved and no driving pressure was exerted to make the men work harder or faster.

The benefits were obtained through creating in both workers and supervisors *a real interest in developing the easiest and best ways of performing each phase of the job;* by helping them plan and schedule the individual work assignments thus balancing the work load within the crews and obtaining smoother operation.

The improvement in the manpower-effectiveness of these crews is shown in the upper graph. From a starting point of less than 70 per cent effective use of the manhours actually paid for, the operations showed an increase to nearly 90 per cent effectiveness, gauged by the same standards over a period of approximately 16 months. The labor cost per standard dollar's worth of work dropped from $1.48 to $1.14 as a result of this improved effectiveness. (This simply means that if the amount of work required to complete a certain job cost $100 with labor used to full effectiveness, then the actual cost of that job dropped from $148 to $114 during the 16 months experimental period.)

● **Workers stress improvement.** Gains of this kind are not made by spectacular changes, but by thorough, intelligent observation and analysis of every step in the work process. Most of the ideas for improvement come from the workers themselves once interest in getting the work done in the easiest and simplest way has been created.

The worker definitely benefits by finding easier ways of doing his work by establishing the fact that he is working more effectively, thus providing himself with a more stable employment. This program quickly discerns between the man who is not really needed, who is being habitually laid off, and the man doing a competent job at the most practical cost to the employer.

● **Industry must consider operating costs.** An example of the little things that go to make up the substantial improvements in operation cost is illustrated in Fig. 2. In connection with the maintenance and repair of old pipe, during the war days when new pipe was not obtainable, leaky pipe lines were uncovered and repaired by spot welding, clamping, or replacement of short sections in the extremely bad spots. This required tar coating and wrapping for protection against corrosion after the repairs had been completed.

The time graphs in Fig. 2 illustrate the useful work performed by each of the five men in the crew, designated as operators "A," "B," "C," "D," and "E." The black sections indicate the working time and the white sections the unused or waiting time. For example, op-

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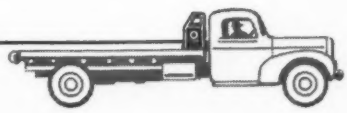


erator "A" carried the hot tar from the kettle to the desired location in a pail of suitable size for handling.

Upon arrival, operators "B" and "C" took over the pail and coated the pipe down in the trench by the sling method, the first man pouring and the second man distributing the tar with the sling. After a short semi-hardening interval, the other two operators, "D" and "E", applied the wrapping and inspected the seal.

● **Time losses explained.** During the time that the first man returned to the tar pot to refill his pail, and came back to the job, each of the other members of the crew were progressively idle as their part of the work was completed. To look at the job casually nothing was wrong, as every man in the crew worked diligently whenever there was work for him to do. There was no holding back or soldiering.

The seriousness of the situation is clearly shown in the first tabulation, however, where we find that 41.7 manhours of work were paid for, but only 20.1 were actually utilized. Thus more paid time was lost than was utilized.

A very simple and inexpensive solution was suggested in the purchase of a second pail so that the tar carrier could keep the supply continuously available for the men applying the tar to the pipe. Although this did not entirely eliminate the standby time and provide perfect crew balance, it did reduce the lost time from 21.6 manhours to 4.5 manhours, and reduced the total manhours paid for from 41.7 to 24.6. It will be noticed that the necessary work, or the manhours utilized, did not change, as the work content of the job was the same in both cases.

This example of simple methods analysis is not cited as a remarkable feat of engineering achievement, but as a type of change that is the very foundation of all improvement in labor utilization. Remedies as apparent as the solution in the case cited are often brought to light when factual data can be developed and the practicability of the correction demonstrated.

● **Work analysis required.** The reduction of 23 per cent in the department labor cost indicated in Fig. 1 ($1.48 to $1.14 per standard dollar's worth of work) was an accumulation of many small increments. Some were quite apparent, others quite obscure until the work was carefully analyzed, measured, discussed with the workers and supervisors, and practical improvements developed.

The job requires the interest and cooperation of everyone from the lowest to the highest level of responsibility. Tangible appreciation for suggestions, ideas, and improvements will go far toward accomplishing the main objective of work simplification and cost reduction.

Each small brick in the protective wall of effectiveness you are trying to build into your operations must be carefully inspected, carefully placed, and its relation to every other brick carefully studied.

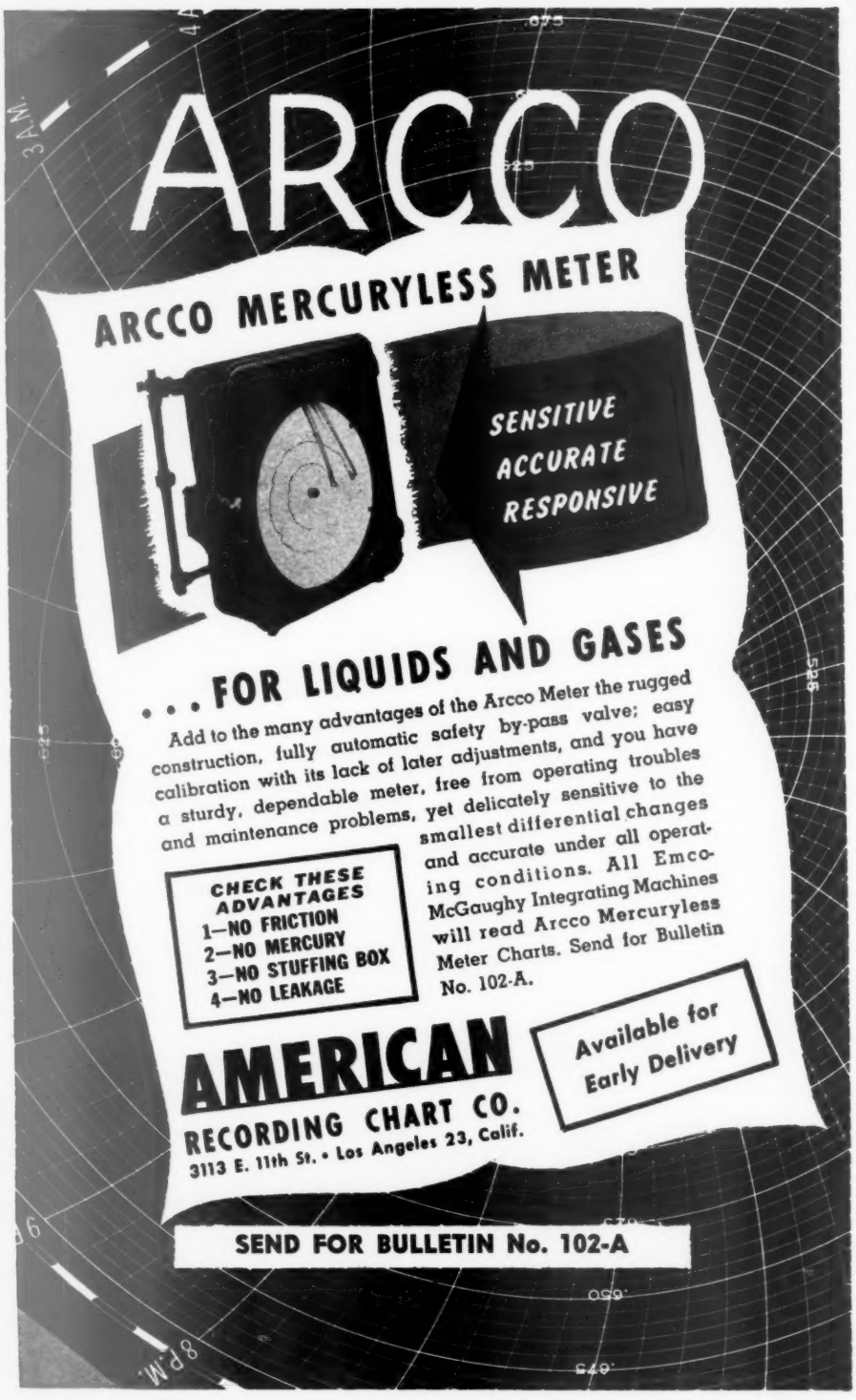
An improvement in one direction may be overbalanced by disadvantages at a different stage in the process. The need for careful analysis, weighing of effects, evaluation of changes, and correlation of the whole effort cannot be overemphasized. Changes at one point may point to substantial benefits at that particular spot, but may cause hardship or additional effort and cost at another point—perhaps in another department—if not carefully considered and analyzed.

Every industry and every business is continually striving for the end result of the improvement of operations that we have been discussing here. Some go far and succeed, others are content to leave well enough alone and let their competitors outrun them and prosper.

The rate of improvement that must be attained is often dictated by current conditions. If competitors are creeping up and it is a matter of survival of the fittest, then the rate must be accelerated, if not then the urge to improve profits is the driving force.

● **Cooperation means lower costs.** There are many ways of accelerating cost reduction, although the more rapidly the changes are made, the more carefully plans must be laid and developments controlled. As already stated, the essence of the whole idea is the cooperation of *everyone* concerned in the drive to reduce cost and simplify work.

During the war much was written about the urge of patriotism, which in view of world conditions almost become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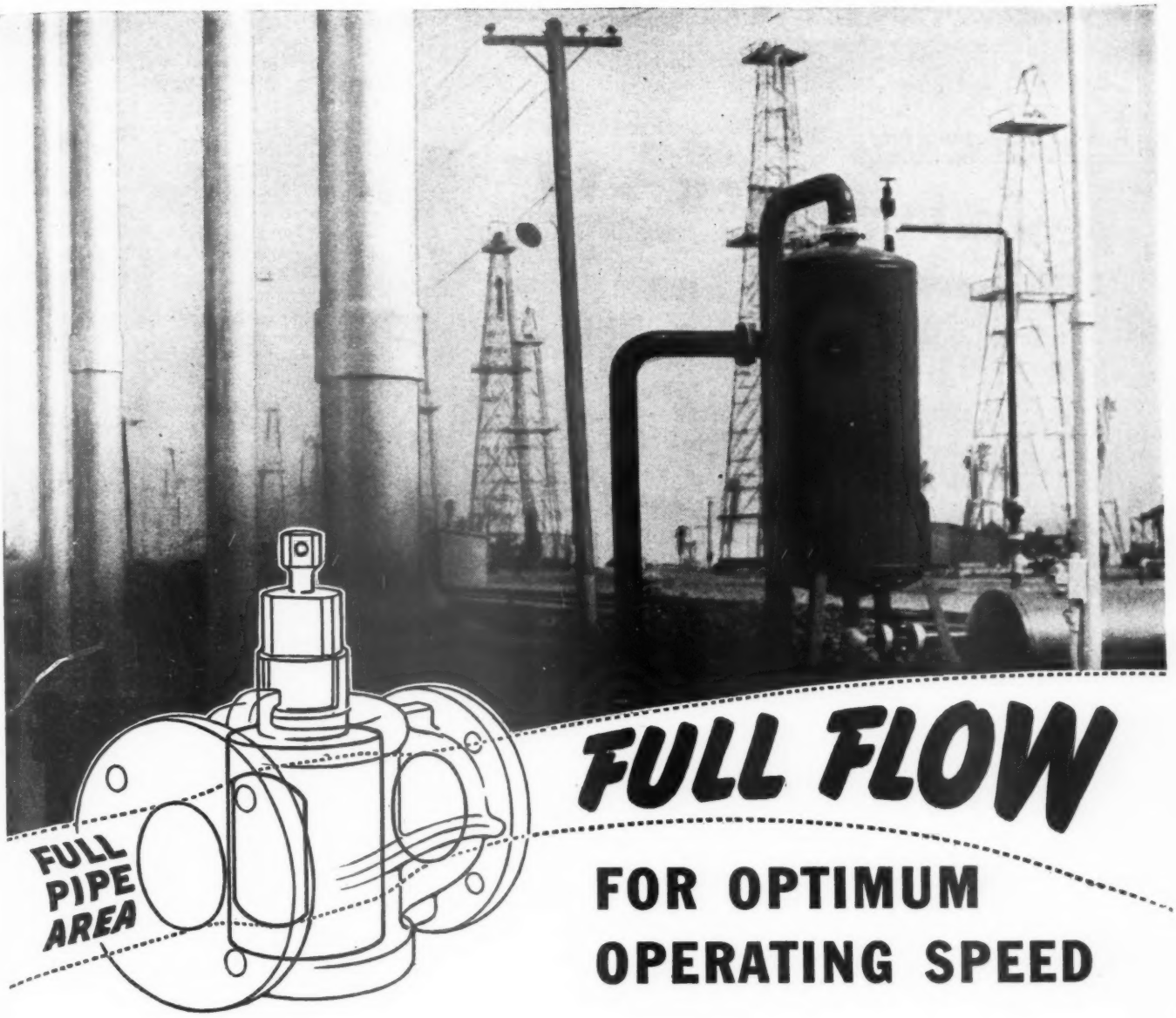

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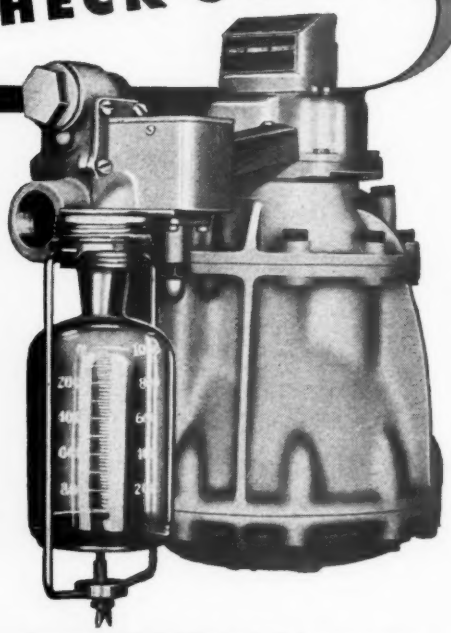

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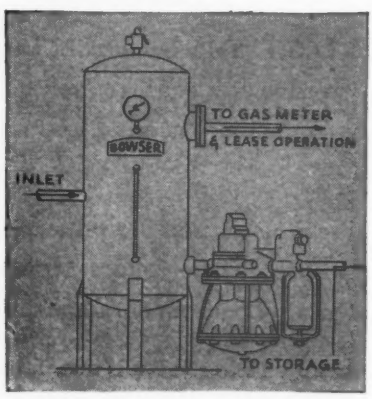

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self-preservation. Wages went up, and patriotism was not only self satisfying but very profitable.

Postwar thinking has turned more toward security and earnings to meet inflated prices. Money talks in the pay envelope, and if there is a real justification for additional earnings as a reward for a better than normal performance in quality and quantity, the additional earnings are warranted and will give substantial reductions in cost. The basis of performance comparison must be reasonable, the goals attainable, and the whole plan economically sound.

There are many patterns for financial incentive, some good and some bad. Some good ones have been abused, and some bad ones have been so distorted as to appear good, even though they are carelessly constructed and full of expediencies. A sound plan must be fair to the employe, and with reasonable aptitude, training, and effort, he must be able to increase his earnings substantially over what he would receive for average, normal performance.

A sound plan must also be fair to the employer, in that the basis for additional payments to employes must be substantiated by additional output above the normal expectancy. Both the basis and the administration of the plan must be fair to both the employer and the employe if it is to endure and accomplish the desired purposes.

● **Operating team required.** Incentive plans are designed to accelerate results over what can normally be obtained by ordinary progressive methods. In the same general type of industry as the cases already cited, Fig. 3 shows the accomplishment in a pipe shop where the work was carefully analyzed, time measurements made, time standards established and introduced as a basis for a sound incentive plan.

The upper graph shows that the effectiveness of the use of the manhours paid for increased from 53 to 87 per cent in a period of four months with a corresponding reduction in labor cost of $1.89 down to $1.15 per standard dollar's worth of work. The direct comparison of the two operations should not be made on a literal arithmetic basis, as the pipe laying work was almost entirely manual work, whereas the pipe shop operation involved machine capacities as well as labor utilization. The difference in the rate of improvements under the two methods of getting results is quite apparent, however.

In machine operations the basis for incentive must recognize the mechanical limitations, and include the utilization of both the manpower and the equipment in the plan of additional earnings for outstanding performance.

To the writer, the most important consideration in any of the problems mentioned is an open, complete understanding between employer and employed concerning the true objectives of the company operation. The full understanding and trust is worth fighting for, and once obtained, will make the operating team one that cannot be beaten. ★★★

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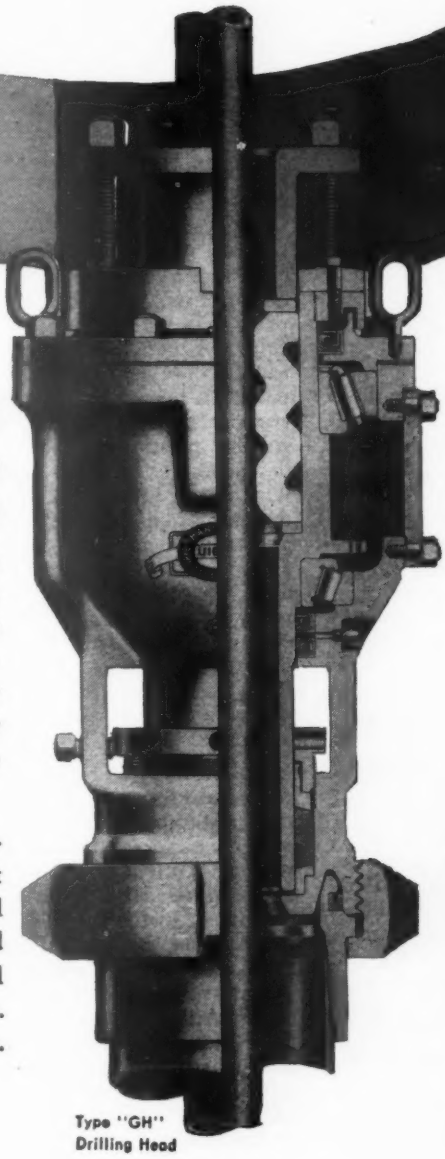

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Gas developments and trends in South Texas*

By **C. R. WILLIAMS,** *Vice President*
The Chicago Corporation

THE close of the war found a greatly expanded natural gas industry, supported by adequate reserves, looking forward to an unprecedented position in the postwar era. Long and vigorous research, conducted principally by private interests in the natural gas and related industries, had expanded frontiers to a horizon never before anticipated. The worth of the commodity had gained recognition, its by-products were well established, its potentialities indicated, and its questionable past largely forgotten. The future of the young industry lay before it, then as now, hopeful but undetermined.

Beginning as an unwanted foundling when the drillers' bits in search of oil encountered sands in the earth that produced gas instead of crude oil, it soon began to plague its discoverers. Most oil prospectors would have rather drilled a dry hole than encounter only gas, and many had their equipment destroyed by the gas pressure. Gas presented a case of too great a supply for the demand, or it was too far removed from the consumers to make it of value with the limited facilities for delivery.

To most people, natural gas is known simply as a fuel used in millions of heaters and stoves. The gas used commercially consists almost entirely of methane and ethane, two hydrocarbons whose characteristics make them resist change from the vapor state in which they exist. They do not condense into liquid at atmospheric pressure until they reach minus 259 F in the case of methane, and minus 128 F in the case of ethane. When produced from a well, gas is ordinarily composed of varying amounts of propane, butane, pentane, and heavier hydrocarbons. Some of the hydrocarbons are extracted as a liquid to be included in motor fuels, and others are extracted and used as liquefied petroleum gas. This liquefied petroleum gas is bottled in pressure containers to be used as fuel for consumers in isolated areas. The proportion of the heavier components is much smaller than the methane and ethane generally contained in gas.

In spite of the varied uses of some of its components, gas is thought of primarily as a fuel because it can be used in small quantities with inexpensive equipment. It is very convenient for domestic use and for this reason, is a premium fuel, requiring little or no attention on the part of the consumer. Gas is also used in industrial operations generally as a substitute for coal or oil; however, in certain special industrial uses, gas is indispensable. The choice between natural gas, oil, and coal in industry depends, in most instances, on the relative price of these fuels; however, due to the convenience in the use of gas, it will generally support a higher price than other fuels for the same heat value. Although natural gas itself is rapidly developing into a source of raw materials for the manufacture of certain chemicals, principally in the fields of rubber, plastics, and carbon black, it has generally been the butane and propane in the natural gas that are used as the raw materials. The requirement for gas in this field is considerably limited, as only a small portion of the gas produced in the United States will supply many times the raw material needed for chemicals at present. It is not conceivable that the market will expand to anything like the amount that would be necessary to consume our entire production of natural gas.

Unlike most other fuels, natural gas can be transported only by pipe line. Its transportation to the consumers who require it either as fuel or raw material presents varied and unique problems and requires large sums of capital for investment in the facilities required. As the demand for natural gas fluctuates with seasonal requirements, the facilities must be prepared for peak requirements. All these conditions combine to make the transportation of gas extremely expensive, and it cannot be produced, transported, and stored as other fuels, but must be produced approximately as it is consumed.

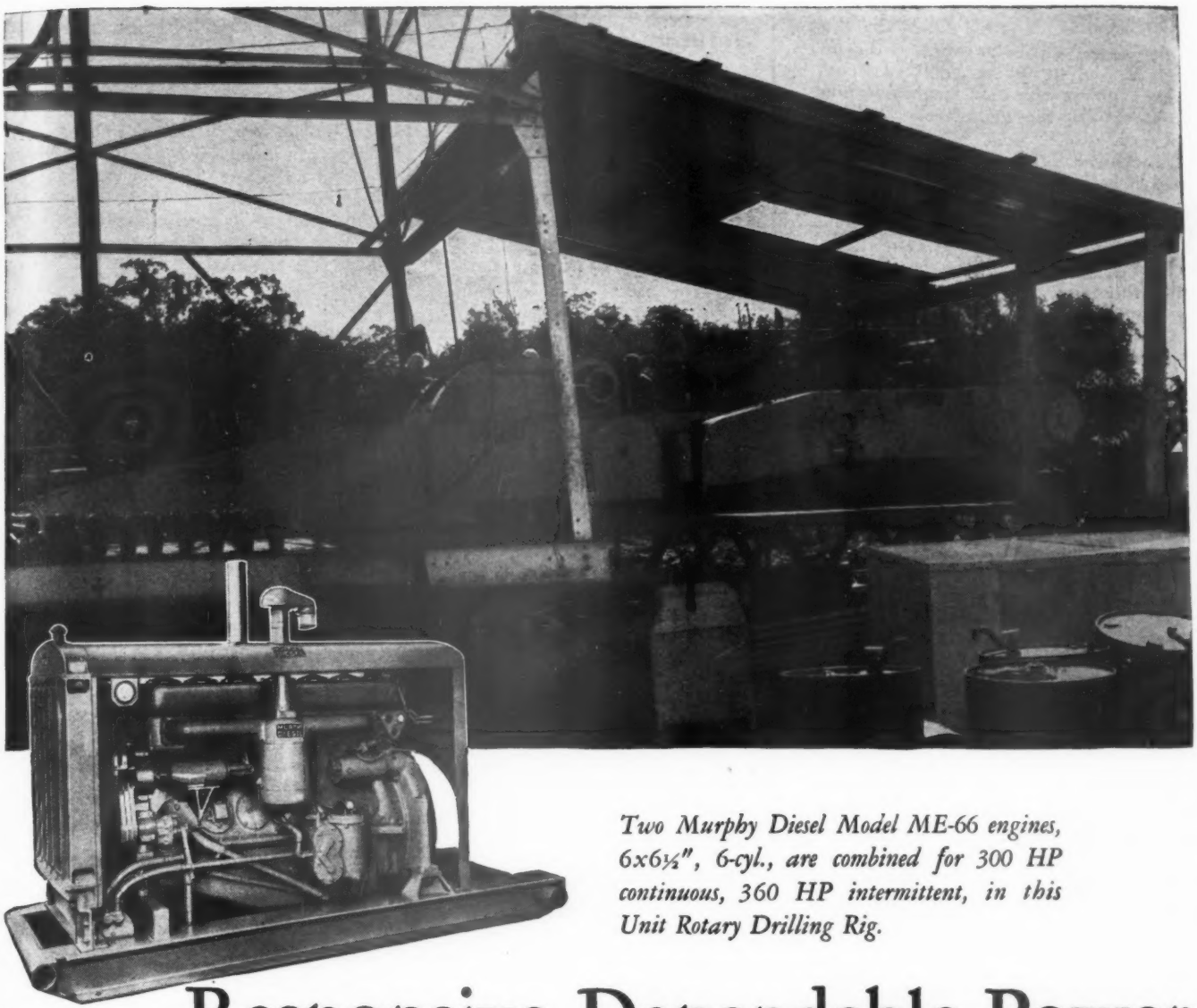
The estimated natural gas reserves of the United States are approximately 150 trillion cu. ft., whereas the proved oil reserves are estimated to be in excess of 21 billion bbl. The Gulf Coast area now has proved gas reserves in excess of 45 trillion cu. ft. Of these reserves, the South Texas area alone has between 25 and 30 trillion cu. ft., and the State of Texas contains approximately 58 per cent of the total reserves of the United States. Within the last 15 years, most of the known gas reserves in the Gulf Coast and South Texas areas have been discovered. The depth of drilling has increased steadily, and the gas reserves found have been proportionate to the increased depths. It is probable that the improved equipment and technique that has made it possible for the industry to drill deeper in recent years will result in additional discoveries of gas. A much more favorable ratio of natural gas production to gas reserves is noted than in the case of oil. The present trend shows sufficient supply for a period in excess of 35 years, and with the potential supply increasing annually, it is very probable that gas will continue to maintain a reserve ratio substantially in excess of production.

Gas consumption during the last four years of war shows an increase of approximately one and one-half trillion cu. ft. annually. At the beginning of the war, the annual gas consumption in the United States averaged approximately two and three-quarter trillion cu. ft. and at the close of the war, it had increased to four and one-half trillion cu. ft. annually, an increase of more than 50 per cent in less than four years. This great expansion in the industry was made possible by the large developed reserves that were not being used at the beginning of the war. Gas was the most convenient fuel that could be produced with the minimum of material and man power per thermal unit delivered to industries manufacturing war materials and supplies. The industry increased its service to many consumers by rendering both heat and power to customers' factories at a time when rail transportation of other fuels was critical or unobtainable. This expansion finds the gas industry facing a postwar period with its war demands continuing and an increasing demand for gas, both as a result of its convenience and the increasing labor and transportation costs encountered in making other fuels available. Its future will apparently be retarded only by the cost as compared with that of its competitors, which are principally coal and oil.

There are, at present, several pipe line companies contemplating expansion of gas sales from the State of Texas, and largely from the South Texas area. One line is now attempting to expand its facilities for transportation and sale of gas into our neighboring country of Mexico to the south. Another company is proposing a 30-in. gas line to the west coast for the transportation of approximately 600 million cu. ft. daily, and one of the present pipe line companies is now expanding its facilities for the transportation of gas into the eastern industrial area from approximately 260 million cu. ft. daily to 600 million cu. ft. daily. Many bidders are trying to obtain the "Big" and "Little Inch" oil lines for the transportation of gas to the New York area in amounts ranging from 300 to 600 million cu. ft. daily.

Gas in the eastern industrial area is now worth approximately 25 cents per M. cu. ft., when compared with coal, on the basis of its heating value. When transportation costs of gas are consid-

*Presented at joint meeting, Texas sections, American Institute of Mining and Metallurgical Engineers, at the University of Texas, Austin, December 18 and 19, 1946.



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ered, however, it is not likely that the value of gas will be in excess of 8 cents per M. cu. ft. in the fields of South Texas, unless economic factors not now apparent develop to influence the fuel market.

Technical developments through research before the war and expanded as a war measure, both in this country and abroad, will have a marked bearing on the future value and use of natural gas. The Fischer-Tropsch process, although discovered some 25 years ago, is now developed to the point that one commercial operation is being installed in the vicinity of Brownsville, Texas, at a cost of approximately $20,000,000. The economics of this installation indicate that natural gas may be worth from 8 to 12 cents for the manufacture of such liquid fuels as motor and aviation gasoline. The ultimate realization of such price will require accessibility to adequate gas reserves to afford a long-time operation and will depend largely on the duplication of small scale results in larger commercial plants.

Another factor influencing the value of natural gas is the conversion of coal to methane and ethane. This process was improvised, using the Fischer-Tropsch synthesis, for the manufacture of gas in Germany during the war. Recent American developments and application of known technique indicate that synthetic natural gas, having a heat content of approximately 1000 Btu's per cu. ft., may be expected in the near future by using the developments of Germany in the Fischer-Tropsch process in connection with American practices in oil refining technology. Such gas, it is estimated, can be produced at a relatively high pressure from coal at a cost of from 16 to 20 cents per M. cu. ft. As the coal mines are available near the eastern industrial installations, it can readily be seen that when such developments are completed, the transportation of gas from the Texas area will not justify a very high price at the wells. Consequently, it would appear that the ultimate future price of gas will be influenced largely by the successful development and operation of the Fischer-Tropsch synthesis in converting natural gas to gasoline and liquid fuel rather than its export for industrial fuel to the eastern manufacturers.

The conservation of gas as a natural resource is largely dependent and contingent upon the value that can be placed on natural gas. One of the most significant gas conservation developments was begun in 1936 in the nature of a pressure maintenance plant for the return of casinghead gas produced with the crude oil in a field in Louisiana. The casinghead gas was first returned to increase the production of crude oil by maintaining the reservoir energy for lifting the oil. Since then many such operations have been started and in many fields, the ultimate production of crude oil has been doubled because of the return of this gas, and the gas has been conserved for sale or use at some future date when the oil has been depleted.

Helium sales

Government sales of helium to commercial users of the United States are expected to average more than 1,000,000 cu. ft. monthly during the fiscal year 1947, the greatest volume of the gas ever used industrially, Dr. R. R. Sayers, director of the Bureau of Mines, has announced.

On the basis of new commercial contracts being negotiated for 1947 by the Bureau, sole producer of helium, former industrial consumption will be surpassed.

Another significant gas conservation measure has been the development of the cycling plants, the first of which was started in South Texas in 1936. In the last eight years, the cycling industry has grown to a total of 27 plants, handling approximately 2 billion cu. ft. of gas daily, and producing approximately 60,000 bbl. of liquid hydrocarbons in the process. The cycling operation was conceived to convert the then practically worthless gas reservoirs to present values, and to hold the leases until such time as markets could be developed for natural gas. The cycling plant also solved the problem of preparing the gas for market as natural gas produced from a reservoir cannot be normally delivered to pipe lines because of the retrograde condensation that might take place and cause difficulty both in transportation and use.

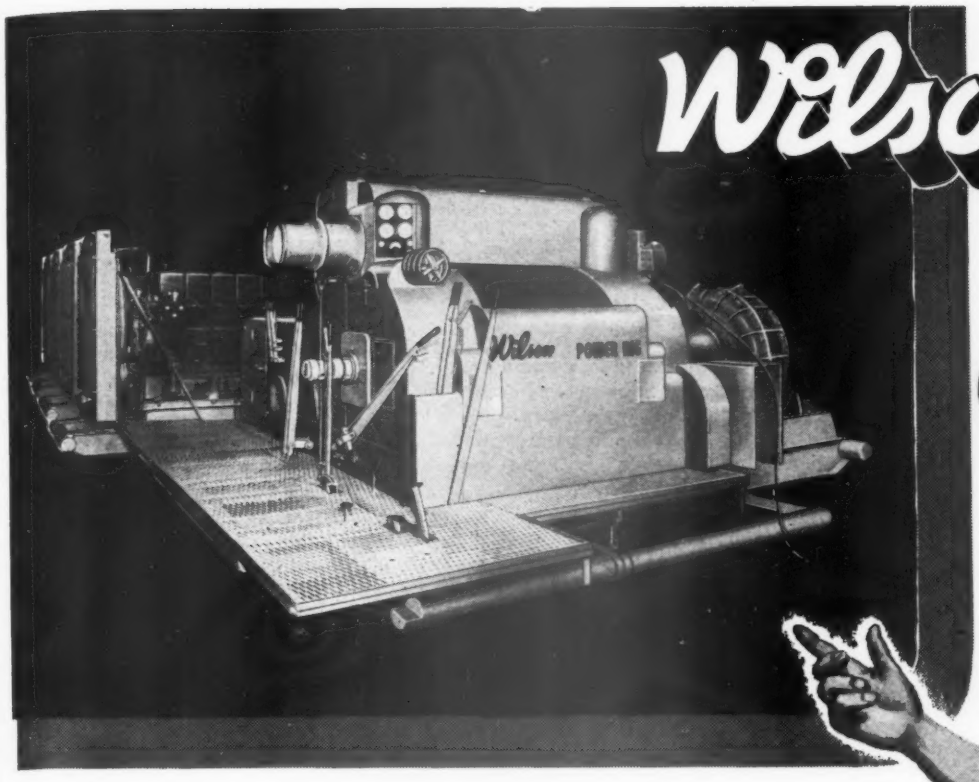
Conservation has, however, received its greatest boost from increased wellhead gas prices, making it practical to conserve this vital raw material. This has been accomplished to date through the long distance transmission lines that are now operating and from those projected in the near future. They either offer a market or promise one in the near future at a relatively fair price, permitting the gas well operators as well as the producers of casinghead gas from crude oil to obtain a market affording a return commensurate with their investments. From the operation of interstate pipe lines, both producer and consumer will gain. Those who consume gas will experience a more desirable result because of its convenience and cleanliness, and the producer will receive a fair return.

There is one fly in the ointment casting a cloud on free play of competitive enterprise. This exists as a result of the Natural Gas Act. When this act was originally enacted, producers believed that the jurisdiction of federal agencies was clearly limited to (1) the transportation of natural gas in interstate commerce, (2) the sale of gas in interstate commerce for resale to the consuming public, and (3) natural gas companies engaged in such interstate transportation or sale. In this belief, the producers of gas were content and continued their normal business of discovery and production, little realizing that this Natural Gas Act would rise to interfere with their operations. The erroneous interpretation of the natural gas act has recently been brought home with its far-reaching effects on the producer. The Federal Power Commission would reduce the wellhead price of gas moving in interstate commerce by limiting the return to about 6½ per cent of the total investment of the producer, without regard for the risk taken or other factors influencing the cause for exploration and development. The Federal Power Commission would destroy competition in the fuel market by prescribing the "end use" for natural gas. Such a policy, should it be successfully imposed upon the producers, would also affect the producers of crude oil. It would act as an anchor to the entire petroleum industry. The progressive strides thus far made in the field of conservation would be materially handicapped.

To eliminate free enterprise and the competitive position of gas in industry would eliminate or restrict the means for disposal of large quantities of natural gas in South Texas resulting in a depression of the market, the shrinking of taxable values, and loss of revenue to the state. It would further result in waste of the raw material that could be used to better the standard of living of distant consumers.

Oil and gas exist together in most reservoirs; they are inseparable twins. It is generally impossible to produce oil without producing gas. The inability to separate them during production clearly indicates the danger in the trend to place the entire petroleum industry on the basis of a utility, making business risks in the production phase impossible.

Some of the more important factors influencing the trends of development and use of natural gas in South Texas have been presented here. Today the trend is to increase the wellhead price of gas with the accompanying improvements in conservation practices under state control. New markets for natural gas are at the threshold, consisting of both interstate pipe lines and the use of gas for conversion to liquid fuels. Interstate pipe lines must be allowed to continue their service. The petroleum industry must not allow the attempts of the federal government to enter the domain of production through the Federal Power Commission's regulation of gathering systems. All-out efforts must be used to prohibit the control of field price and end use of gas by any government agency, either federal or state. The industry must be assured that wellhead prices will receive their true place in a free and democratic economy, so that it can continue with confidence and stability in developing the natural, God-given resources of our great country. Only under such conditions can this nation's, or any nation's, great natural resources be developed to their most efficient use, either in time of crisis, or to maintain and improve the standards of living for its people in time of peace. ★★★



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Simplified pipe line computations

By **PEYTON BRYAN,** *Assistant Division Engineer,* Humble Pipe Line Company

PART 3—*Conclusion*

In the two previous installments we have seen that the general d'Arcy equation for pipe line flow, $h = f\frac{l v^2}{2 g d}$, can be reduced to an equation of the form $h = a B^n$. In this equation, B is the rate of flow in bbl. per hr., h is the hydraulic gradient in feet of liquid per 1000 ft. of pipe, n and a are constants for any specific grade of crude flowing in a given pipe diameter, provided the flow is turbulent and falls within commercially feasible limits for the given diameter.

EXCLUSIVE

One advantage of thus incorporating the friction factor, f, into the other constants is that direct solutions for rate of flow from a given hydraulic gradient become possible by a couple of operations on the log-log slide-rule. Another is the greater facility permitted in complex flow problems. For instance, consider Fig. 1-a, which is the profile of a three-battery gravity system from which oil is to be gathered into a field pump or suction pump of a station at point O.

Assuming no vacuum effect from the pump, it is obvious that any flow through the 2000 ft. of 8-in. pipe, L_o, will require a hydraulic gradient h_o, and that the elevation of the gradient, H_o, at Junction

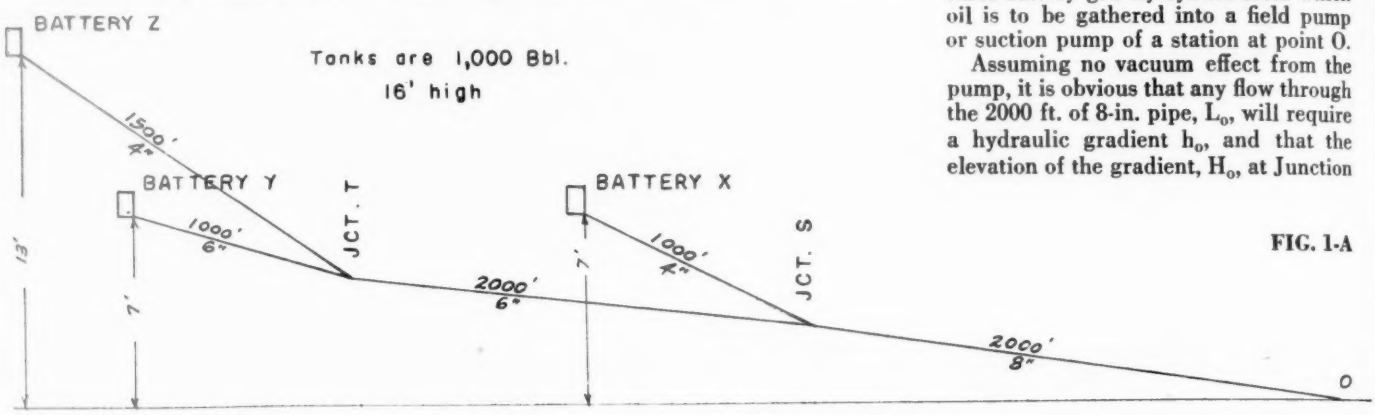

FIG. 1-A

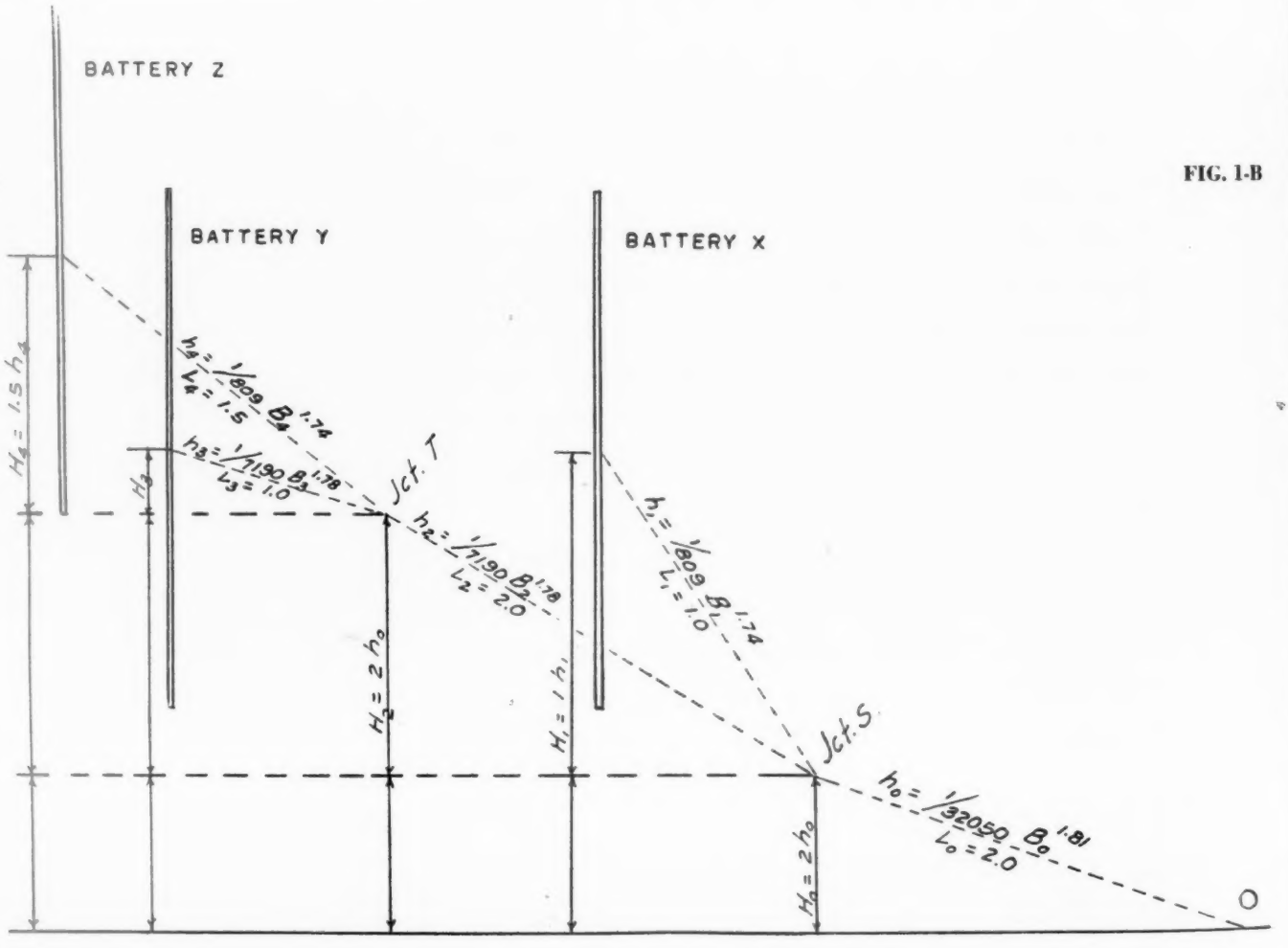

FIG. 1-B

One advantage of thus incorporating the friction factor, f, into the other constants is that direct solutions for rate of flow from a given hydraulic gradient become possible by a couple of operations on the log-log slide-rule. Another is the greater facility permitted in complex flow problems. For instance, consider Fig. 1-a, which is the profile of a three-battery gravity system from which oil is to be gathered into a field pump or suction pump of a station at point O.

Assuming no vacuum effect from the pump, it is obvious that any flow through the 2000 ft. of 8-in. pipe, L_o, will require a hydraulic gradient h_o, and that the elevation of the gradient, H_o, at Junction

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the ***Follow Through*** we mean starts when construction begins . . . the ***Follow Through*** of the engineer, foreman and erection crews; their abilities, their cooperation, their attitude of helpfulness and understanding of the importance for an efficient job . . . that's what we at ***Hammond*** mean by ***Follow Through.***

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"... my purpose in writing you is to offer my thanks for what I consider a very satisfactory job, performed by an efficient organization. I think this is unusual especially as my only contact with you folks has been by mail and telephone. At this time I would like to commend your erection foreman, Mr. ..... upon his ability, co-operation and general helpfulness. To my mind he is a superior person. Rest assured that on the basis of this job, alone, you have all our future jobs."

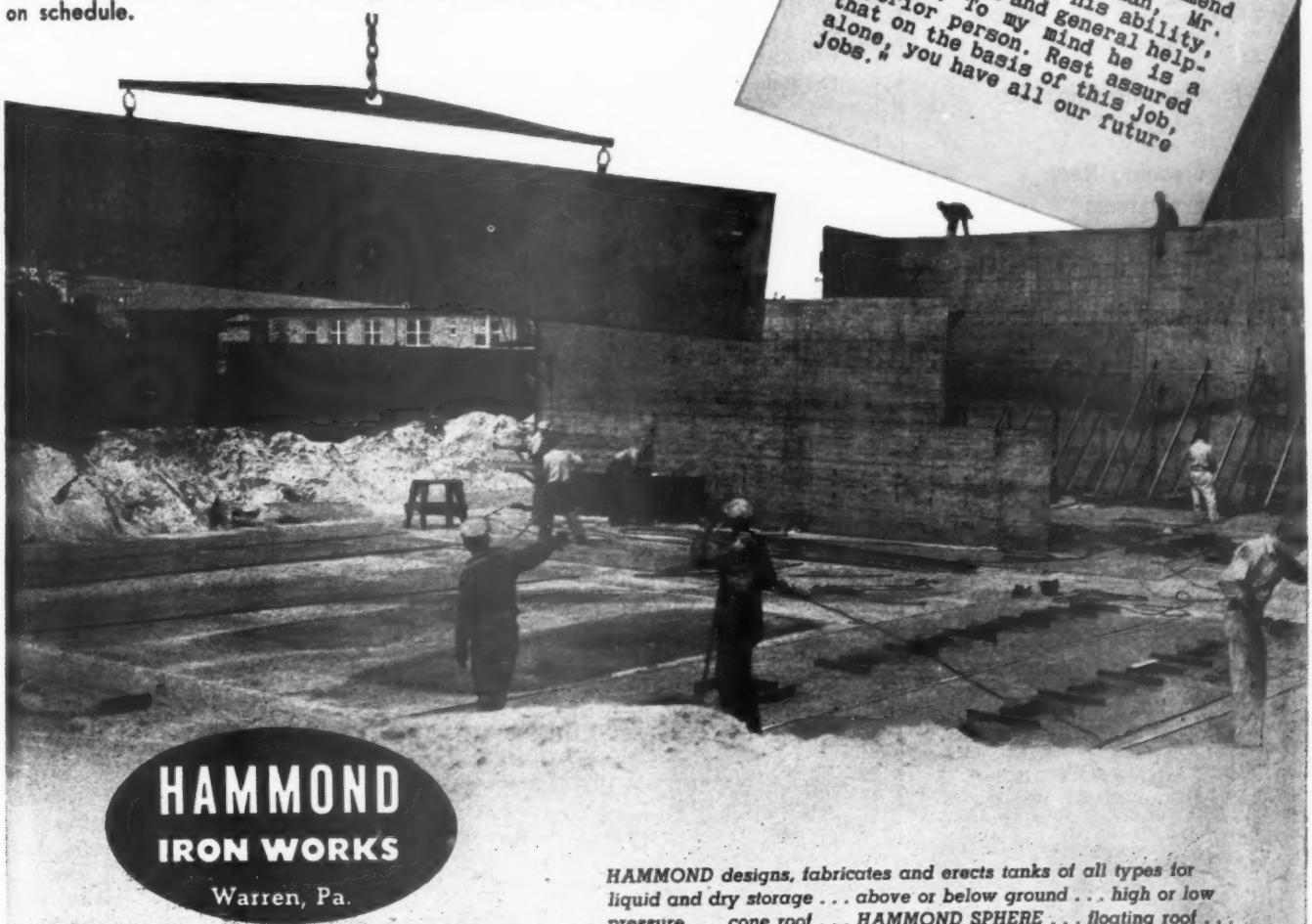

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TABLE 1

Assumed value of B_o	$B_o^{1.81}$	$240{,}000 - B_o^{1.81} = 19.8\ B_1^{1.74}$	B_1	$B_o - B_1 = B_2$	$4.46\ B_2^{1.78}$	$240{,}400 - B_o^{1.81} - 4.46\ B_2^{1.78} = 2.23\ B_3^{1.78}$	B_3	$96{,}600 + 2.23\ B_3^{1.78} = 29.7\ B_4^{1.74}$	B_4
450	63,400	177,000	186	264	91,100	85,900	377		
550	91,200	149,200	169	381	175,000	−25,800	...		
500	76,800	163,600	178	322	129,500	34,100	224	130,200	123
505	78,100	162,300	177	328	134,100	28,200	202	124,300	121
504	77,900	162,500	177	327	132,300	30,200	206	126,800	121

S will be $L_o h_o$. Similarly, any flow through the 1000 ft. of 4-in. pipe from Battery X will require a gradient h_1, and the elevation of the gradient at Battery X will be $L_o h_o$ plus $L_1 h_1$, or H_x. For flow through the 2000 ft. of 6-in., L_2, there must be a gradient h_2, and the elevation of the gradient at Junction T will be H_T, equal to $L_o h_o$ plus $L_2 h_2$; also, for flow from Battery Y through 1000 ft. of 6-in., L_3, there will be a gradient h_3, and the elevation of the gradient at Battery Y is $L_o h_o + L_2 h_2 + L_3 h_3$. At Battery Z, the elevation of the gradient is $L_o h_o + L_2 h_2 + L_4 h_4$.

It will be necessary to express these various values of h in terms of their respective flow rates, B, and since equations for a crude of 42-deg. API gravity and 35 SUS viscosity were derived in a previous article, we will assume that to be the grade in the tanks. These equations are:

For 4-in pipe
$h = 1/809\ B^{1.74}$ $\quad B = 46.73\ h^{0.57}$
For 6-in. pipe
$h = 1/7190\ B^{1.78}$ $\quad B = 145\ h^{0.56}$
For 8-in. pipe
$h = 1/32050\ B^{1.81}$ $\quad B = 308.6\ h^{0.55}$.

A rigorously precise solution of this problem would have to take into consideration the varying and unequal fall in oil levels of the three tanks. It would not be such a simple example of flow under a falling head as was discussed in Part 2 of this article, but would be so complicated by the interdependent rates in loss of head by all three tanks as to require a whole complex of partial integrations, which seem overly nice for the character of our data. Hence, as a "design convention," we will take as the effective head at each tank the elevation of its bottom point O, plus one-half the height of oil in the tank. This is conservative, with a margin to take care of friction losses through the various pipe fittings. From Fig. 1-b, the gradient diagram for these conditions:

$$H_x = L_o h_o + L_1 h_1 = (2)(1/32050\ B_o^{1.81}) + (1)(1/809\ B_1^{1.74} = 15 \text{ ft.}$$

I. $B_o^{1.81} = 240{,}375 - 19.8\ B_1^{1.74}$

$$H_y = L_o h_o + L_2 h_2 + L_3 h_3 = (2)(1/32050\ B_o^{1.81}) + (2)(1/7190 B_2^{1.78}) + (1)(1/7190\ B_3^{1.78}) = 15 \text{ ft.}$$

II. $B_o^{1.81} = 240{,}375 - 4.46\ B_2^{1.78} - 2.23\ B_3^{1.78}$

$$H_z = L_o h_o + L_2 h_2 + L_4 h_4 = (2)(1/32050\ B_o^{1.81}) + (2)(7190\ B_2^{1.78}) + (1.5)(1/809\ B_4^{1.74}) = 21 \text{ ft.}$$

III. $B_o^{1.81} = 337{,}000 - 4.46\ B_2^{1.78} - 29.7\ B_4^{1.74}$

Subtracting II from III:

IV. $29.7\ B_4^{1.74} = 96{,}625 + 2.23\ B_3^{1.78}$.

The trial values should be tabulated, somewhat as in Table 1, in order to follow the effects upon the variables of changes in the assumed values of the total flow rate B. The example was worked with a 10-in. log-log rule, which accounts for the rounding-off to three significant figures. The solution in Table 1 shows the total flow rate to be 504 bbl. per hr., made up of 177 bbl. per hr. from Battery X, 206 bbl. per hr. from Y, and 121 bbl. per hr. from Z.

It has been the practice in some offices to calculate the flow rate of each individual battery, with nothing else "on the line," and to assume that the battery with the "best" gradient will be the only one flowing until it has been emptied, whereupon the second-best battery will come on the line, and so on. The seriousness of this fallacy, in causing the possibilities of gravity-systems to be overlooked, is illustrated in our example.

To solve for the flow rate of Battery X, alone, we need to convert the hydraulic gradient existing in the 4-in. line to an equivalent gradient in the 8-in. As the rate of flow through each of these lines obviously will be the same, we can equate their respective flow equations:

$$46.73\ h_4^{0.57} = 308.6\ h_8^{0.55}$$
$$\therefore\ h_4 = 27.5\ h_8^{0.96}$$

Referring to Fig. 1-b:

$$2\ h_8 + 27.5\ h_8^{0.96} = 15 \text{ ft.}$$
$$h_8 = 0.5 \text{ ft.}$$
$$B = 308.6\ h^{0.55} = 211 \text{ bbl. per hr.}$$

Similarly, for Battery Y, it is found that the equivalent 8-in. gradient is 1.11 ft. per 1000 ft., and the rate of flow for Battery Y alone would be 326 bbl. per hr. Effecting the same substitutions for Battery Z, the flow rate for that battery alone is found to be 188 bbl. per hr. Now, if as a matter of practical operation it is required to run 1000 bbl. of oil from each battery in an 8-hr. day, it is apparent that pumps will be required for at least two of the batteries, for this method of calculation indicates that slightly more than 13 hr. are needed for gravity flow. Actually, the gravity rates are sufficiently high, when correctly computed, to deliver more than the required runs for an 8-hr. day.

★ ★ ★

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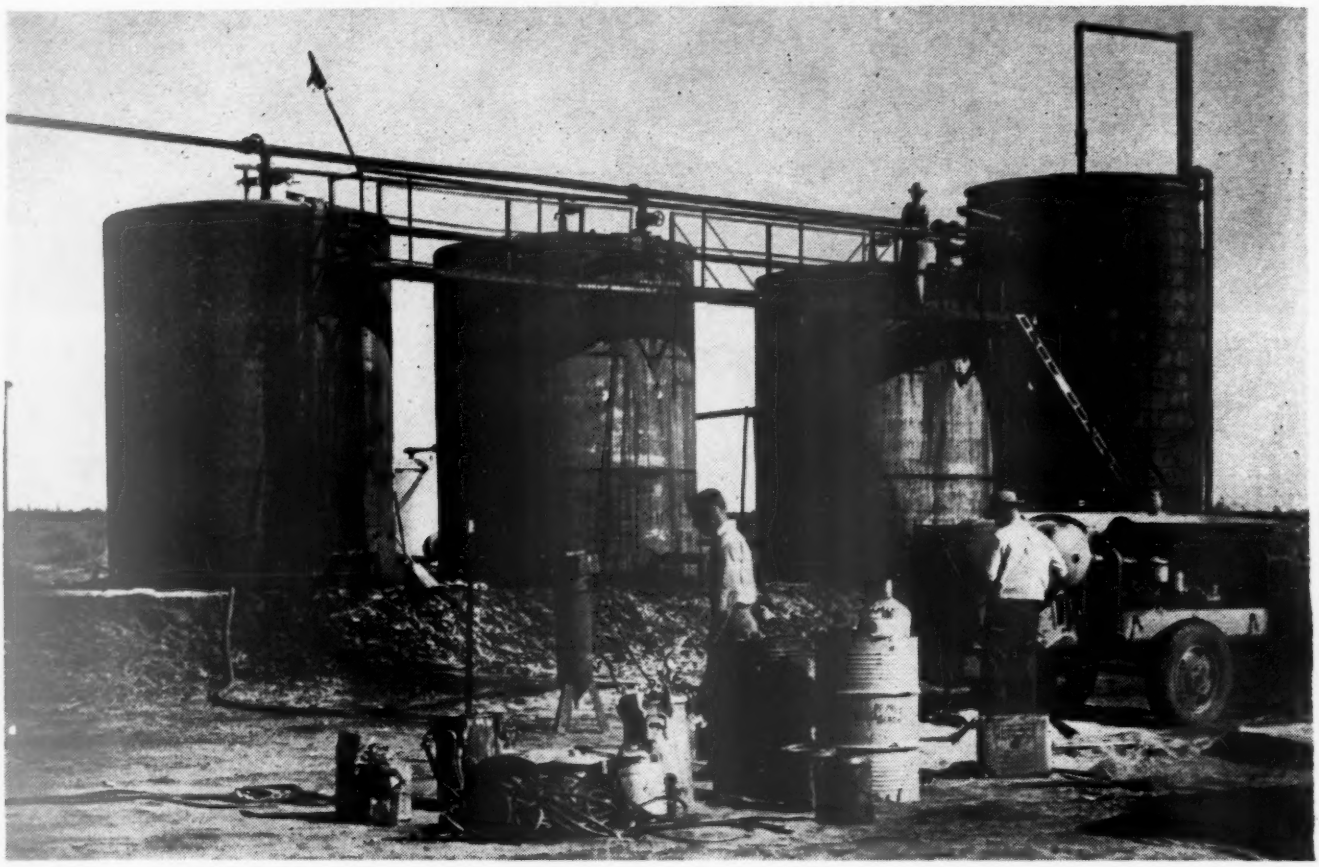


A tank battery about to be treated to a plastic coating after being subjected to sour oil. Sand blasting and paint spraying equipment are moved to the fire wall and give ready access to all three tanks.

Applying plastic coating to oil tanks

By **WILLIAM J. DAVIS**

THE constant fight against petroleum corrosion by both major and independent producers, representing a yearly loss estimated in the millions of dollars, has been advanced by developments accelerated by the recent war.

EXCLUSIVE

Aboveground equipment has received much more attention with respect to this problem than sub-surface equipment, perhaps because the former is constantly before the operator's eyes whereas the latter is not evident until something goes wrong down in the hole.

Manufacturers have had difficulty in producing a product that was inherently uncorrodible or a product that, when applied to any surface exposed to corrosion, would act as an effective inhibiter and in both cases keep the cost within reason.

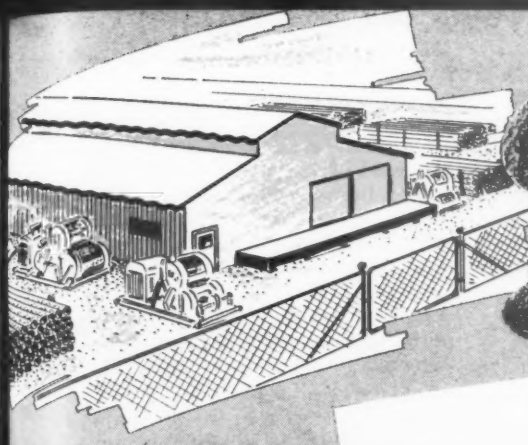
A favorite testing ground for such new products has been the sour oil production area centering around Crane and Ector counties, West Texas. This area has been a headache to producers for years with its salt water complication and varying conditions of corrosion from well to well. What would prove to be corrosion-resistant tankage and separator equipment on one lease as often as not failed completely on an adjoining lease.

Some producers have switched from steel to wooden tanks, others from wooden tanks to steel, and some from welded to bolted tanks or the reverse, all with limited success.

The trend, however, has been toward the development of inhibiter coatings and their proper application, in this particular area, which may well point the way for other areas not so badly affected but still having a problem of corrosion.

An example of the type of coating and the techniques of application currently being used for steel tanks, separators, concrete surfaces, and even acid tanks can be found in a product developed by the Goodyear Tire and Rubber Company called Resoweld.

Resoweld is the trade name applying to a family of thermoplastic resins commonly known as plastics in the form of primers and paints developed primarily for the purpose of combating petroleum corrosion. Subsequent to development in the Goodyear laboratories the product has been subjected to West Texas sour crudes since 1943 in which it passed from an experimental stage after 18 months' trial to what is now regarded by many operators as a practical means of combating corrosion in aboveground equipment.



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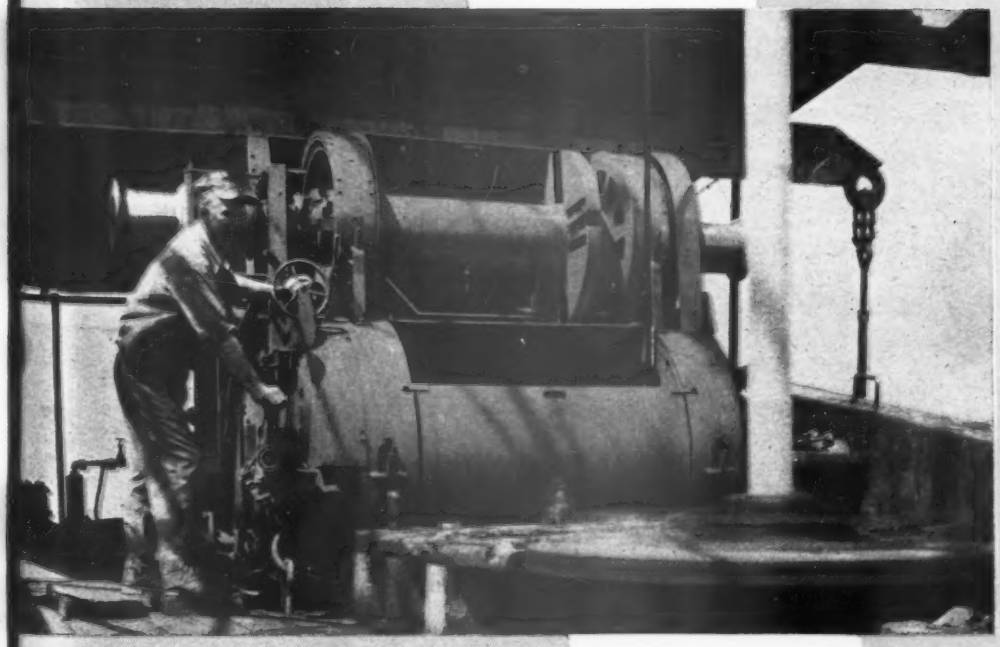

Model "R" with spudder or beam is available with third drum. Recommended for cable tool drilling to 7,500 feet or well servicing to 10,000 feet. Rotary table drive assembly, interchangeable with spudder or beam assembly, is available for 5,000 foot drilling or rotary workover jobs to 10,000 feet.

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Above, an angular sand is used in blasting to insure the greatest cutting action. It must be free of moisture, which is made possible with the aid of a sheet of tank steel and wood fire. Constant turning while drying breaks up cakes and assures uniform exposure to heat.

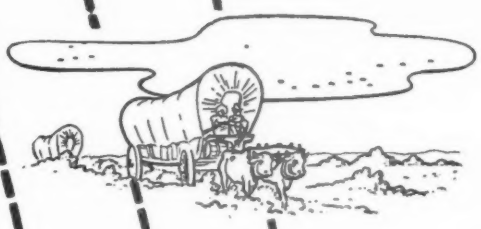
No small amount of ingenuity has been used by Lloyd R. French and Son, pioneer licensed to apply Resoweld, to bring about the closest duplication of field application to laboratory practice, for it is in the technique of application and preparation of the surface to receive the inhibiting plastic that permits the full realization of its properties for protection.

Two types of service are available. The first is the treating of old equipment to arrest further corrosion by sour crude. The second is the treating of new equipment as soon as erected and preceding service in which sour crude is anticipated. The latter service has come as a natural sequel to favorable results from the first type of treatment.

The treatment of a given piece of equipment can be divided into two steps. The first is the complete cleansing of the surface to be treated, not only of oil, old paint and oxide, but mill scale must also be removed down to the bare metal by the use of sandblasting equipment. The importance of this step and the care with which it must be executed cannot be overemphasized. The second step is

After two screenings, sand is loaded by hand into hopper of the sand blasting compressor, shown below. The hopper holds enough sand for approximately 45 minutes blasting.

Air-fed masks are used in both sand blasting and spraying operations. Extra clothing must be worn to protect the operator from the flying particles of sand while working on tank interiors.



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Roof, walls, and structural members are given a thorough blasting, including the removal of original mill scale.

In finishing up blasting operations, facing of manhole is carefully cleaned back to gasket line.

the painting of this surface, before it has a chance to oxidize, with primer and followed by the proper number of top coats recommended for a given corrosive condition.

Assuming the treatment of a high 500-bbl. tank subjected to corrosive crudes, the following data may be taken as average time, quantities, and procedures, which are to be decreased or increased in proportion to the amount of corrosion encountered.

The treating crew, consisting of two men and a supervisor, take over the tank as soon as it has been released by the tank cleaning crew. Sand is spread in the bottom to absorb the remaining BS&W while the crew carries on the work of cleaning the roof and walls.

Sand for blasting the interior of the tank is carefully selected. It was thought at first that any sand sufficiently free from foreign matter would be satisfactory, but experiment has shown that washed beach sand composed of angular grains give best cutting results. Furthermore, the selected blasting sand is first coarse-screened and then fine-screened through a ⅛-in. mesh as it enters the hopper on the compressor.

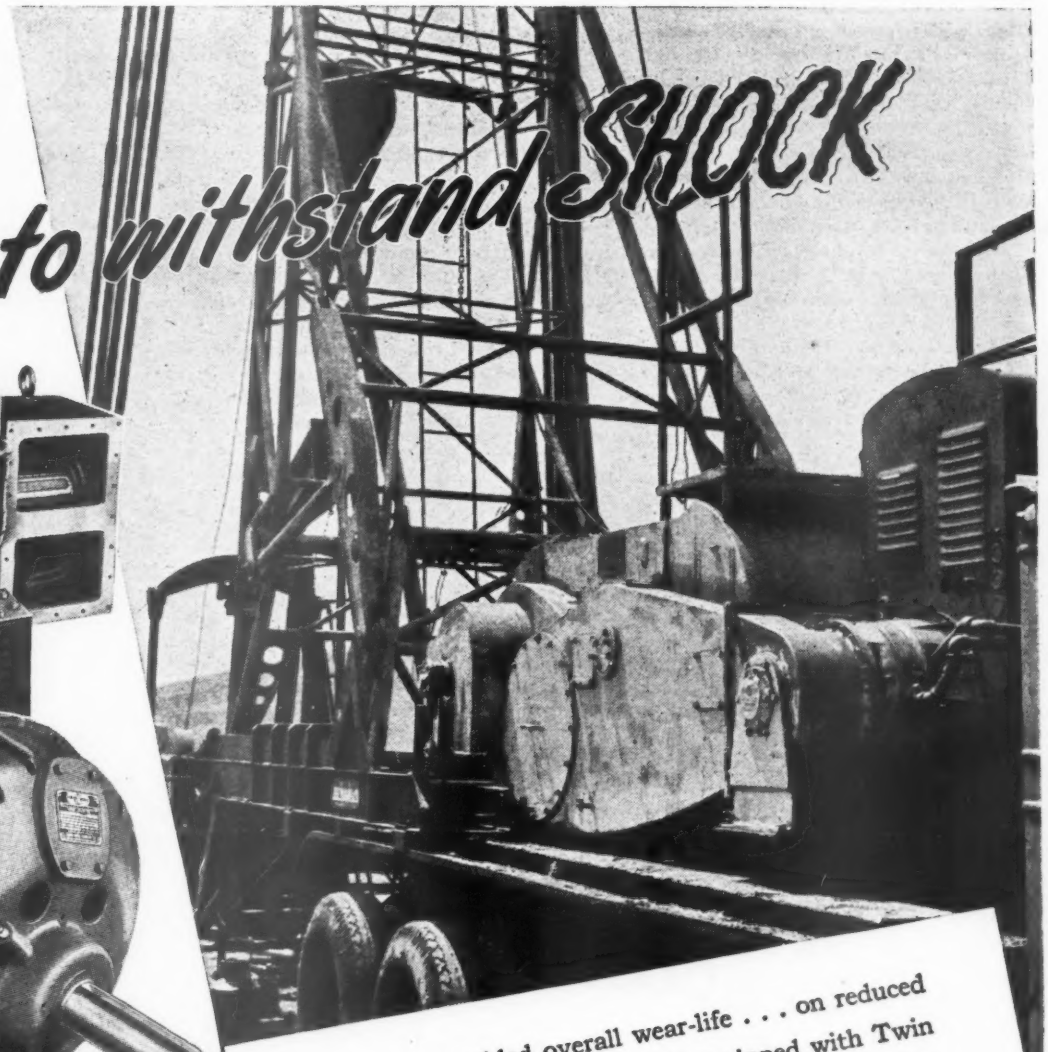
The sand hopper is constructed to hold from 600 to 700 lb. of dry sand at one loading and is built as a single unit with the 105 or 160 cfm mobile compressor. One loading of sand lasts approximately 45 min. and from two to four yards of sand are required for one 500-bbl. tank, depending on the tank's condition. This sand is dried on the job prior to loading into the hopper by spreading on a tank sheet under which a wood fire is kept going. An hour is average drying time for one yard.

Blasting pressure is about 100 psi through a 1-in. hose and a ¼-in. quick-change tip at the end of the blasting hose. This tip is replaced from four to six times per tank as they wear out, thus a nearly constant ratio of sand-to-air prevails throughout the cleaning operation.

Each sandblaster is provided with a mask to which fresh air is constantly

Mixing of plastic paint requires that top coats be thinned 20 to 25 per cent. Alternate colors of black and white are used to indicate complete coverage.

Built to withstand SHOCK



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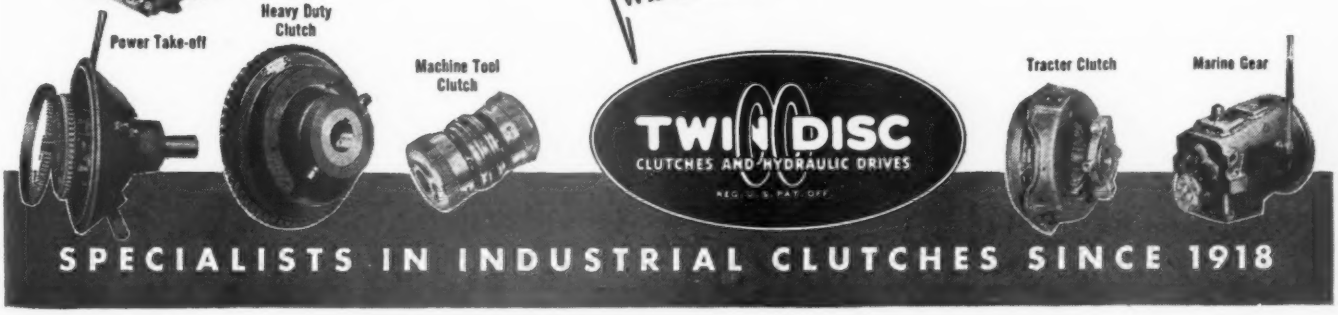


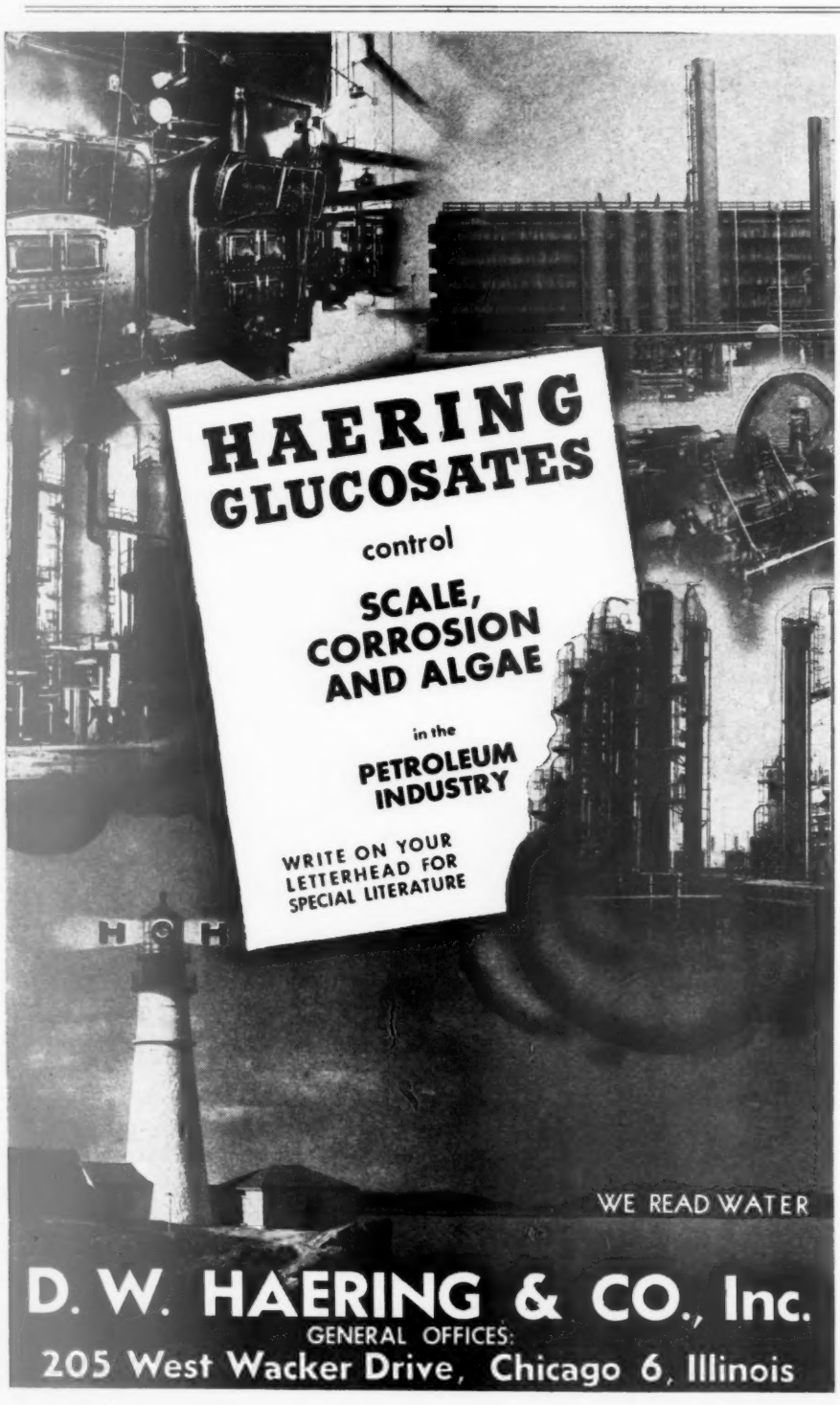
SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

supplied by bleeding a small volume of air from the main compressor through a pressure reducer and a ½-in. hose. Clothing is worn of a nature to protect the blaster to the fullest extent from the flying sand.

A helper is provided to dry new sand, keep the hopper full, run the compressor, and aid the blaster when necessary. It is not necessary that he wear a mask, for he is seldom in the blasting area and never enters the tank while this operation is being carried on.

In sandblasting the interior of a tank, all vents are opened to atmosphere. All cover plates, structural members, roof supports, roof, and floor are blasted with equal care. The accumulated sand is shoveled out and brooms are employed to sweep down walls and floor. Sand is never used but once as it is contaminated and its cutting efficiency is greatly reduced once it has been used.

A clean stream of air blows out the tank after which the fine particles are allowed to settle. Next a fine-hair broom is used to again brush down the walls and floor and all other surfaces to be treated. In the case of riveted tanks, a vacuum cleaner strapped to the blaster's back is used to remove dust from seams. All gasket material at the chime is trimmed back flush to insure complete coverage by future coats of plastic.



At this point both crew members remove their shoes before wiping down the interior with clean, dry rags and, once completed, the cover plate is put on to prevent dust entering the tank. Primer is immediately applied before any oxidation can take place or the surface become contaminated, in an effort to duplicate laboratory procedure as nearly as possible. In the case of larger tanks that cannot be blasted completely in one day, only enough surface is cleaned as can be treated with primer the same working day.

Upon final inspection by the supervisor after the sandblasting and cleanup, the tank is ready for painting. Three materials are used consisting of a red primer known as M-194-C, top coats in either black or white labeled M-195-C, and clear thinner known as M-199-C. The order of painting is first the primer, unthinned, then black M-195-C thinned 20 to 25 per cent, after which comes alternate coats of white and black M-195-C also thinned to the same consistency. Usually the primer coat and three top coats are all that are necessary, though more can be added if deemed advisable.

Spraying has been found the best method of application, though the first tests were brushed on. Coverage is in the nature of 150 to 200 sq. ft. per gal. at a pot pressure of 25 to 30 psi and a gun pressure of 60 to 75 psi.

Air fed masks are also used in the spraying operation as well as the cleaning operation. It has been found that primer and top coats dry and cure sufficiently in the time it takes to change the spray guns over from one color to the next. The alternate colors are used to aid the spray gun operator in getting complete coverage with each. Total thickness of primer and three top coats should be about 8 mils and the resulting coat is a thin, tough, coating that cannot normally be broken by a cleanout rake in clean-out operations.

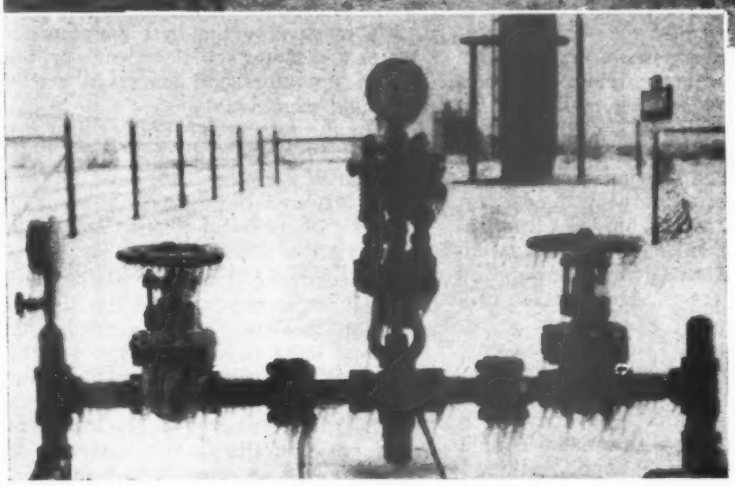
The only change in spraying equipment for handling plastic paint is that the spray head has from eight to ten ports instead of from two to four. Equipment must be cleaned immediately after use in order to keep it in working condition.

For complete curing after the last coat, the tank is left open from 48 to 72 hr. after which it is ready to be put in service.

It has been found good practice to treat a 2-ft. square of tank steel and place it on the bottom under the thief hatch to provide a striking plate for either a thief or gauger's plumb bob.

The above-described procedure has been used to recondition separators at less than one-third the cost of a new piece of equipment. Both transit and permanent acid tanks have also been treated successfully for prolonged life. In the case of one tank battery that required the replacement of one or more tank sheets every 90 to 100 days, the treatment was applied and there have been no sheets replaced for three years.

★ ★ ★



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P 934.314.

The safety program in Saudi Arabia

By **R. A. COUGHLIN,*** *Chief Safety Engineer,* Arabian American Oil Company

EXCLUSIVE

THIS discussion of the safety program in Saudi Arabia will follow a sequence of thought built around these major points: First, that to fully understand the Arab, his underlying philosophy, his conceptions, and to share his viewpoints one is compelled to travel back to the dawn of civilization—for theirs was an old country and their way of life fairly well fixed before America was even identified. Second, that all human activities and attitudes in industry must be reviewed in the framework of any social change. Third, that it is comparatively easy to produce ideal blueprints for the conduct of people and forget the dependency of even the best plans upon the actual people who will execute the details. Fourth, that whereas there are certain basic factors deemed essential for the success of any program, real training must be built upon problems and not on routine. Fifth, that, in general, a safety program in a foreign country is influenced by the class of employes, customs and practices, regulatory measures, climatic conditions, available facilities, as well as many other factors.

● **The Arab.** To carry out effectively any program that has as one of its objectives the bringing about of certain desired changes in people it is only logical that one of the basic requirements is to have at least a minimum knowledge of the people with whom you are dealing. This is not only true with large groups but there is sufficient evidence to warrant the statement that the individual supervisor who is most successful in handling his human relations problems is the one who has taken time out to obtain or develop certain information and knowledge of his men.

In order that you and I might be thinking and talking about the same person, it seems desirable to briefly outline the background of the Arab. If we are to understand the Arab and his way of life, we are compelled to turn the pages of history back to about the year 570 A. D. Here we find the birth of a person who was to have profound influence upon these people. Though the Arabic calendar does not date from the birth of Mohammed, it does await nearly 50 years when their Prophet made the now famous Hegira (or flight) from Mecca to Medina. Parenthetically, even their calendar differs from ours.

You may ask: "Why such information?" "What has religion to do with a safety program?" Just this: To even remotely understand the Arab the first requisite is to have some knowledge of his religion because his very life, his thoughts, his every move, his laws, are all built around his religion. Failure to understand and appreciate this is not merely the negation of something indifferent—not like leaving blue out of a crazy quilt—it is the omission of something absolute, something necessary. Their religion, second only to Christianity in the number of followers, must always be considered when drawing up blueprints for the conduct of these people.

In this discussion I shall give you what experience and observation permits us to say of the Arab. You should keep in mind, however, that there are two "Arabs." The Arab within Saudi Arabia and the Arab outside Saudi Arabia. I shall omit any reference to those outside. It should be added, however, that the single term "Arab" is responsible for much misunderstanding and confusion.

Even in Saudi Arabia we find more than one Arab. In fact, they can, for all practical purposes, be classfied into three fairly distinct groups:

Those from the Hejaz country, in and around Mecca, are generally recognized as having a background best suited for such positions as interpreters, translators, clerical, and similar positions. This by virtue of the fact that these people have been exposed to a more cosmopolitan way of life and also that this part of Arabia was at times the center of the cultural Arabic world. Public schools and institutions of higher learning are and have been available to those in that locality.

Then there is the Bedouin, the true son of the desert, the nomad of whom you have heard so much. His is the one of the oft-quoted: "Shall fold their tents, like the Arabs, and as silently steal away." In doing so he usually moves at night, not out of an innate love for the darkness, but even he has a certain respect for shade temperatures of 110 to 125 and sun temperatures of 125 to 150 degrees.

His exposure to an academic life has been limited by the very nature of his nomadic life. Although these people may be found "short" according to the "books", the fact that they have been able to cope with all the vicissitudes of a ruthless desert for more centuries than we care to think of is sufficient proof that they possess natural abilities and adaptability to qualify them for at least a "run-off" for the title of the most versatile of the Saudi Arabs. This has been found to be true, especially in fitting them into an undertaking such as we have in Saudi Arabia. From these people we have been able to develop the best gangpushers, truck and motor vehicle drivers, drilling crews, operators, and general all around oil field workers.

The third group, generally referred to as "townspeople," although the blood brother of the other two, have not, as a rule, acquired the mental ability of the one nor the physical stamina and adaptability of the other.

● **The advent of an industrialized life.** I shall not attempt any lengthy dissertation of the historical background of the Arab. I think it is sufficient to say that anything bordering on industrialization, as we have come to think of it, is and has been a complete reversal of their pastoral and nomadic life that has existed for centuries. If, however, we are to understand and appreciate the impact that industrialization has had, it seems that some information is essential.

It took the Western World, or, if you prefer, America, more than two centuries to reach its present stage of technical development. Almost over-night we brought the accumulation of these centuries into use in Saudi Arabia. Until the discovery of oil in eastern Saudi Arabia in 1936, the only occupation even approaching an industrialized life was that of building sail boats, fishing, pearl diving, date growing, gardening, raising sheep, and other such allied occupations coupled with the normal channels of trade.

Obviously, none of these provided a background that could be utilized in the development of one of the natural resources of their country. In fact, their language did not even provide for a common medium of expression for such things as derricks, drilling rigs, refineries, stabilizers, pipe lines, and the hundreds of tools, equipment, and materials, as well as many of the occupations that we who have spent years in the industry have long accepted as commonplace. It is only natural then for the novice in Saudi Arabia to consider sometimes our problems as insolvable.

Those of us who have attempted to

*R. A. Coughlin, chief safety engineer for Arabian American Oil Company, has been connected with the petroleum industry for almost 20 years. A native of Mount Airy, Maryland, Coughlin began his oil career in 1927 with Humble Oil and Refining Company. He joined Arabian American in July, 1944, as a safety engineer in Saudi Arabia. In December, 1945, he was promoted to his present position.

Coughlin returned to the United States this fall on vacation following completion of his first two-year tour of duty. It was during this period that he was able to attend the National Safety Congress in Chicago, where he made his report on his company's safety program in Saudi, Arabia.

Coughlin is now preparing to return to Saudi, Arabia, to begin his second tour—a tour that will be shared by his wife, who expects to join him as soon as housing facilities are available.

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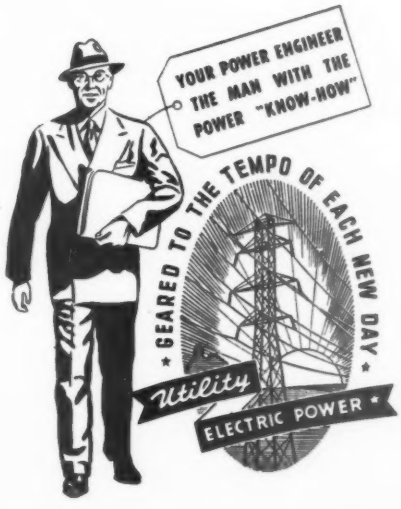

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analyze these problems have, at times, classified them as bewildering but at the same time recognize them as constituting an alluring challenge.

● **Specific problems.** In our attempt to direct the work activities of the Saudi Arabs, as well as the many other foreigners such as Italians and Indians, our number one problem is of course the language barrier. Although some Americans have become fairly proficient in the spoken Arabic more have developed a sort of pidgin Arabic. Under such conditions there is always the question of an exact meeting of the minds. There is always that doubt in the mind of the American supervisor as to just what part of his instructions or orders he has conveyed; just what part has been understood. This condition, conceivably enough, accounts for many of our accidents and resultant injuries.

We accept this problem as one of our perennials and feel that through the classes for Americans to learn Arabic as well as those for the Arabs to learn English, that in due time this problem will not hold the position it does today.

● **Training and education.** Due to the emergency nature of our undertaking under wartime conditions, our training and educational program has not been as complete as it might have been. The distance that we would have had to travel to overcome the background of the people we were to train was too great and time did not permit. We were compelled to train, in the normal methods of private enterprise, as many as possible to cope with all the problems encountered in the petroleum industry as well as those of a municipality of 10,000 people. Any comprehensive program designed to prevent accidents and provide training in proper work methods must include two distinct phases: (1) That of the immediate or emergency type to alter unfavorable conditions; and (2) the long range preventive program for the purpose of eliminating basic causes. We have made favorable inroads into the first while laying the foundation for the second. In a period of only six years, we have been able to reduce our overall frequency rate from a high of 92 to an expected rate of 25 to 20 for this year.

The magnitude of this program comes into bold relief when one considers that our future gangpushers, leadermen, and those that will hold the key positions are now in the first and second grades of our schools

● **Operational problems.** What are some of the operational problems in Saudi Arabia? Like most questions, this one is easier to pose than answer. Essentially, they are about the same, with some variations, as will be found elsewhere. The problems of the petroleum industry follow a fairly well defined pattern wherever an overall development program is undertaken. Exploration, drilling, producing, transporting, processing, and sales—each is an entity in Saudi Arabia. Each of these units requires the use of Saudi Arabs, consequently each requires special training in order to fit them for the job. Selective employment is beyond the question and training is the only answer. In addition to all the normal operating problems involved in the development of an oil field it is necessary to install and maintain all the facilities required for a modern city.

★★★★★★

From March 1941 to V-J day in August 1945, lend-lease shipments of petroleum products from the United States and offshore areas amounted to more than 510 million barrels, valued in excess of $2,300,000,000.

The problem surrounding exploration and drilling can generally be referred to as a composite of practically all the problems encountered in the States. The depths of the wells compare favorably with those in the States varying from 4,000 to 10,000 ft. plus. Formations encountered require the use of rock bits from surface to bottom.

The equipment required to go to these depths, as well as to withstand intermittent high pressure gas zones, is identical with that used in the States. As all members of the crews, except the driller and assistant driller, are Saudi Arabs our problems naturally center around the training of these people, none of whom had ever been on a rig floor before.

Production problems are those normally expected to be found in prolific oil fields with gas pressures sufficient to deplete all oil in the reservoir. It is generally agreed that one of the major problems results from the high content of hydrogen sulphide in the gas dissolved in the crude oil. Gas analysis indicates these to vary from 2 to 26 per cent by volume or 2,000 ppm to 26,000 ppm cu. ft. May I remind you that according to the American Standards covering exposure to hydrogen sulphide, the maximum permissible allowance for 8 hr. for H_2S is 20 ppm. In addition to hydrogen sulphide, and produced in conjunction with it (though there are those who would question the analysis), is carbon monoxide ranging from 2 per cent upward.

Hence, in order to protect against this combination of gases, we are compelled to use all-service type canisters. Through intensified training and rigid rules we have held an expected high rate of fatalities from this source down to one, which almost astonishes us when we review the records. Though many employes are exposed to this lethal gas every day, only one death has resulted from overexposure to it. This was due to an infraction of the gas mask rule that requires all workmen performing work atop tanks to wear gas masks. Practically all Saudi Arabs performing operations around tanks, such as gauging, sampling, etc., have been given first aid training with emphasis on artificial respiration. Through the use of this training, five people have been resuscitated on five different occasions after overexposure to this gas.

The problems of processing are those of any large modern refinery whose handling of crude oil involves all the complexities of handling hydrogen sulphide crude. Here again we encounter the problem of teaching and training Arabs in the safe practices and work methods of an operation they are seeing for the first time.

An oil-company executive recently returned from a 7 weeks' flying trip through Central and South America, having visited 22 countries and traveled 15,273 miles in 100 hours of actual flying time. A similar trip by ship would have taken 7 or 8 months.

★★★★★★

The pipe line problems are those of a carrier whose entire system is confined to an all-desert country or marine and desert, for some of the longest underwater pipe lines in operation are to be found here.

The absence of suitable highways and the almost impossible task of maintaining roads over the trackless wastelands of the desert do and have presented aching pains in our motor vehicle transportation problems. For all practical purposes "high" gear on the heavy equipment can almost be classified as an accessory. All heavy equipment, such as tractors, heavy-duty trucks, busses, etc., are operated by Saudi Arabs, most of whom have been training during the past two or three years. Although the grueling hauls over the desert trails take a heavy toll in depletion of this equipment, our overall accident experience is not inconsistent with similar exposure.

● **Climatic conditions.** In addition to all these expected problems of an integrated oil company, we are constantly battling the elements of nature, which at times seem to combine forces to discourage those who would dare the intrusion of the desert. Shade temperatures of 110 to 125 F. and sun temperatures of 125 to 150 F. are commonplace during the summer months. Such conditions, although not the most pleasant, are accepted as a matter of course. The real "field" days, however, are those when we have these temperatures together with a "shemal," or sandstorm, with its scorching hot winds; or when it seems as though the Persian Gulf had moved right in on top of you and the psychyometer indicates a reading of between 90 and a 100 for a relative humidity of 75 plus.

● **Accident-injury experience.** I would feel remiss if I failed to mention some of the unusual conditions that influence our accident injury experience. Many of our disabling injuries are not necessarily due to the severity of the injury at the time of the accident but to the general health and physical condition of the injured. Infections due to the failure to heed minor injuries also account for many of them. Although deep inroads have been made into the problems of personal hygiene and sanitation, much remains to be done. The fundamental ideas of cleanliness and sanitation, unknown a few years ago in some of the communities, are beginning to be practiced; and though the task, outside of the communities under company supervision, is tremendous, it is not insolvable.

There are certain regulatory measures

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that prohibit the wearing of the American type safety hats. Consequently, head injuries that could be prevented by this personal protective equipment have to be accepted. We have had extreme difficulties in obtaining sufficient numbers of shoes, which necessitates workers following one of their age old customs of going barefooted or wearing their native sandals, which accounts for many foot injuries. As many of them have never worn American shoes and as a rule those that are obtainable do not conform to their foot structure, we have this as a source of disabilities due to blisters that break and become infected.

Another source of many of our disabilities is the excessive prevalence of trachoma. Eye injuries from wind blown particles and others, occurring under conditions where protective equipment for the eyes would normally not be provided, often result in long disabilities due to the aggravation of this preexisting disease. Though trachoma is a disease and not classified or generally accepted as a compensable injury, we are constantly struggling with the problems of differentiating between the degree of disability due to the injury and that due to the preexisting disease. Our experience with the regulatory bodies administering the compensation regulations allows us to assume that this question will remain a source of debate for some time.

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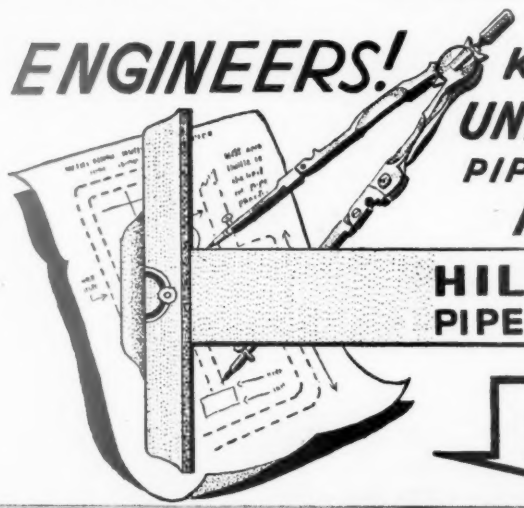

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Although it is generally thought that the Arab is somewhat apathetic toward the continuance of this life, our experience allows us to say that such thoughts are generally metaphorical in nature. He, the same as you and I, has a definite interest in anything that may prolong his life or alleviate or prevent personal injuries. Consequently, a safety program does have an opportunity to survive. As these people have not had contact with the complexities of an industrial world, however, our safety program and industrial education and training had to begin with fundamentals. We have had to return, in many instances, to the same methods and techniques that were employed at the inception of the safety movement that we know today. We have had one advantage, however, in that we have used, as a guide, those things most likely to succeed and avoided those things that were failures.

● **Conclusion.** Time does not permit due reference to all the collateral operations required to support this development: Such as, off-loading of cargo from ships and barges, on-loading of tankers, the marketing of petroleum products, operation of large machine and boiler shops, welding shops, carpenter shops, garages, air-conditioning plants, power plants, warehouses, storehouses, commissaries, all phases of a construction program as well as myriad of other operations required to maintain these communities. Each and every one of these have problems peculiar to their particular operations.

In this presentation I have attempted to outline only a part of the problems we have met and those we anticipate. I am sure that you have found many of the operational problems essentially the same, with perhaps some variations, as the ones you meet each day.

Most of the real problems are human relations problems, for we are all creatures of thought and habit and no program is going to change us overnight. There is hardly a person who does not understand the laws governing the strains and stresses of metal but can we all say that we understand the strains and stresses between human beings? Experience permits us to say, however, that through understanding, education, and training most of these, wherever they may be found, can be solved. Although our realizable ideas and ideals may yet be beyond the horizon and our endeavors call for the maximum of patience, understanding, and cooperation, they can be acquired through the conscious effort on the part of each individual. It seems to me that just to the extent that we understand and appreciate this fact will we be able to determine our progress in clearing out the undergrowth of misunderstanding between people who by birth and by nature have the same objectives in life that you and I have, though they may have been taught different routes by which they may be obtained.

Upon such a foundation of understanding, realizable ideals have a better opportunity to reach maturity. ★★★

Dallas Nomads give December party

The Dallas Nomads, newest chapter of that international organization, entertained with a cocktail party and buffet supper in the quarters of the Petroleum Club in the Adolphus Hotel on December 13. Col. George E. B. Peddy, attorney of Houston, made the address of the evening, being introduced by N. A. Endicott, Continental Supply Company, president of the Dallas chapter.

Colonel Peddy is a veteran of both World Wars. In World War II he was staff officer in the Fifth Infantry Division of the Third Army, and participated in the invasion of Normandy, as well as all campaigns in the European Theater. In recognition of his distinguished service he was awarded the Bronze Star and the French Croix de Guerre. After V-E Day he acted as legal officer and deputy military government officer of the city of Frankfurt, Germany.

In the photograph at the top of the page a part of the gathering can be seen, with Endicott introducing the speaker of the evening. At the bottom of the page on the left Colonel Peddy is delivering his address. Below at right is Endicott at the microphone and seated behind him, left to right, are Shep Miers, Secretary of the National Board of Regents; Colonel Peddy, Charles W. Thornhill, president of the Houston chapter of Nomads, and W. G. Green, Tulsa, chairman of the National Board of Regents.

★ ★ ★

Running Tour WITH MEN IN THE INDUSTRY

• **C. B. Kluppel** has been made chief engineer by Turney Manufacturing Company, Inc., Houston, Texas. Kluppel, who has had more than 15 years' experience in the design and development of drilling equipment, will be in charge of engineering on the power drilling rigs now being produced by Turney Manufacturing Company, Inc. The new rigs feature gear-driven drawworks, air controls, forced feed lubrication, and other improvements. For the last three years, Kluppel has served as consulting engineer in the oil field division of Clark Bros. Co., Olean, New York, and, prior to that, was chief engineer for Portable Rig Company in Houston.

C. B. Kluppel

• **William R. Boyd, Jr.,** president of the American Petroleum Institute, has announced the appointment of **Dr. John W. Frey** as the new director of the Institute's division of marketing. The appointment becomes effective February 1.

• **Albert F. Guiteras,** of Foster D. Snell, Inc., New York City, has been elected president of the New York professional chapter of Alpha Chi Sigma. **Foster Dee Snell,** president of Foster D. Snell, Inc., has been elected an honorary member of the Chemical, Metallurgical and Mining Society of South Africa. He is also president of the American Institute of Chemists.

• **Walter L. Faust,** a vice president and director of the Socony-Vacuum Oil Company, Inc., has been placed in charge of all the company's foreign marketing operations. He will also be chairman of the foreign trade committee. Faust has been in charge of the company's domestic marketing. He will be succeeded in that capacity by **A. L. Nickerson,** who recently returned to the United States after having been chairman of the board of the Vacuum Oil Company, Ltd., London.

• **Francis S. McIlhenny, Jr.,** newly elected secretary-treasurer and director of Sun Oil Company, succeeds **Frank Cross** who died November 25, after serving in that capacity more than 40 years. McIlhenny becomes the second person to hold the position of secretary in Sun Oil Company.

McIlhenny, who is 36, joined the treasury department of Sun Oil Company in 1939 after having been associated with the MacCoy, Brittain, Evans and Lewis law firm in Philadelphia for several years.

During the war he served as a Naval officer for more than two years, part of the time as lieutenant on the staff of Rear Admiral Milo F. Draemel, commandant of the Philadelphia Navy Yard and the Fourth Naval District. Upon returning to Sun Oil Company in 1944 he was named assistant secretary and assistant treasurer.

• **F. C. Buchwalter** has been elected chairman of the Kansas Society of Petroleum Engineers. **R. G. Daley** has been made secretary-treasurer. Both men are of the Great Bend office of Shell Oil Company, Inc. Retiring officers are **H. E. Allen,** chairman, and **P. R. Waddle,** secretary-treasurer. Both are with Carter Oil Company at Great Bend.

• **S. F. Bowlby,** vice president Los Angeles management, Shell Oil Company, Inc., has announced the following staff transfers and promotions:

E. W. Masters, who has been on special assignment in New York, will return from the East shortly to resume his duties as production manager for the Pacific Coast territory. **R. C. McCurdy,** division manager, San Joaquin, has been made manager at Maracaibo. **P. L. Kartzke,** senior exploitation engineer, Los Angeles, is the new division manager, San Joaquin. **W. C. Chonette,** division manager, Shell of Canada, is now chief exploitation engineer, Los Angeles. **P. E. Lehr,** division superintendent, San Joaquin, is now general production superintendent, Los Angeles.

• **Lee G. Miller** has been appointed plant manager by Lebanon Steel Foundry of all its operations at Lebanon, Pennsylvania, Miller was formerly superintendent, and takes the place of **Frank J. Stanley,** resigned. Miller has been with the company 20 years.

• **D. B. Hodges** has been named vice president of transportation and supplies for the Shell Oil Company, Inc., New York, it is announced by **Alexander Fraser,** president. Hodges has been associated with the Shell organization for more than 20 years. Born in Holdrege, Nebraska, he attended the University of Nebraska. He began his career with Shell immediately thereafter in Ventura, California, and progressed rapidly through various positions of increasing responsibility, becoming administrative assistant in manufacturing in San Francisco ten years later, and executive assistant to the vice president in 1939. The following year he came to New York as manager of shipping and supplies. In January, 1946, he was promoted to general manager of the transportation and supplies department.

D. B. Hodges

During the war, Hodges served as associate director of the supply and transportation division of the Petroleum Administration for War.

• **R. Rea Jackson** has been appointed manager of the Paulsboro, New Jersey, refinery of the Socony-Vacuum Oil Company, Inc. He succeeds **Howard W. Sheldon,** who has been transferred to the company's headquarters at 26 Broadway, New York, to become assistant director of Socony-Vacuum Laboratories.

Jackson has been general superintendent of the Beaumont, Texas, refinery of the Magnolia Petroleum Company, an affiliate of Socony-Vacuum, for the last ten years. He joined Magnolia as a chemist in 1923 following his graduation from the University of Texas.

Sheldon was graduated from the University of Michigan in 1917 and joined Socony-Vacuum as an engineer at the Paulsboro refinery in 1926. In 1929 he was transferred to New York and became chief chemical engineer of the research and development department. Four years later he returned to Paulsboro as chemical engineer and in 1943 became general manager of the refinery.

• **C. G. Swank,** assistant district superintendent for Humble Oil and Refining Company in the Conroe district, Conroe, Texas, has been transferred to the Thompsons district, Thompsons, Texas, as acting district superintendent.

W. W. Thames, farm boss, Anahuac district, Monroe City, Texas, has been transferred to the Conroe district, as assistant district superintendent.

A. R. Bruce, farm boss, Tomball district, Tomball, Texas, was promoted to assistant district superintendent at Tomball.

A. J. Mangum, senior gas engineer, Katy gas cycling plant, Katy, Texas, was promoted to assistant cycling plant superintendent.

• **Barton I. Hogarth,** graduate mechanical engineer, has been named to the newly created position of purchase engineer in the equipment and supplies division of the Pennsylvania Salt Manufacturing Company purchasing department, **N. W. James,** general purchasing agent, announces.

• **Ragnar "Rags" Giske,** has been appointed manager of marine sales for the Washington division of the General Petroleum Corporation, it is announced by **Clarence S. Beesemyer,** vice president in charge of marketing. Giske succeeds **Carl J. Waage,** who passed away in Seattle on November 17.

The new marine sales chief, a graduate of the University of Washington, joined General Petroleum in 1934 as a clerk at Tacoma. Subsequently he specialized in lubrication sales and joined the marine sales department as a salesman in 1939. At the time of his present appointment, he was chief marine lubrication engineer at Seattle.

• **Harold S. Silver** has been named general patent attorney in charge of the patent department, legal division, of the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, according to an announcement by **H. W. Story,** vice president and general attorney for the company. He succeeds the late **J. J. Kane.**

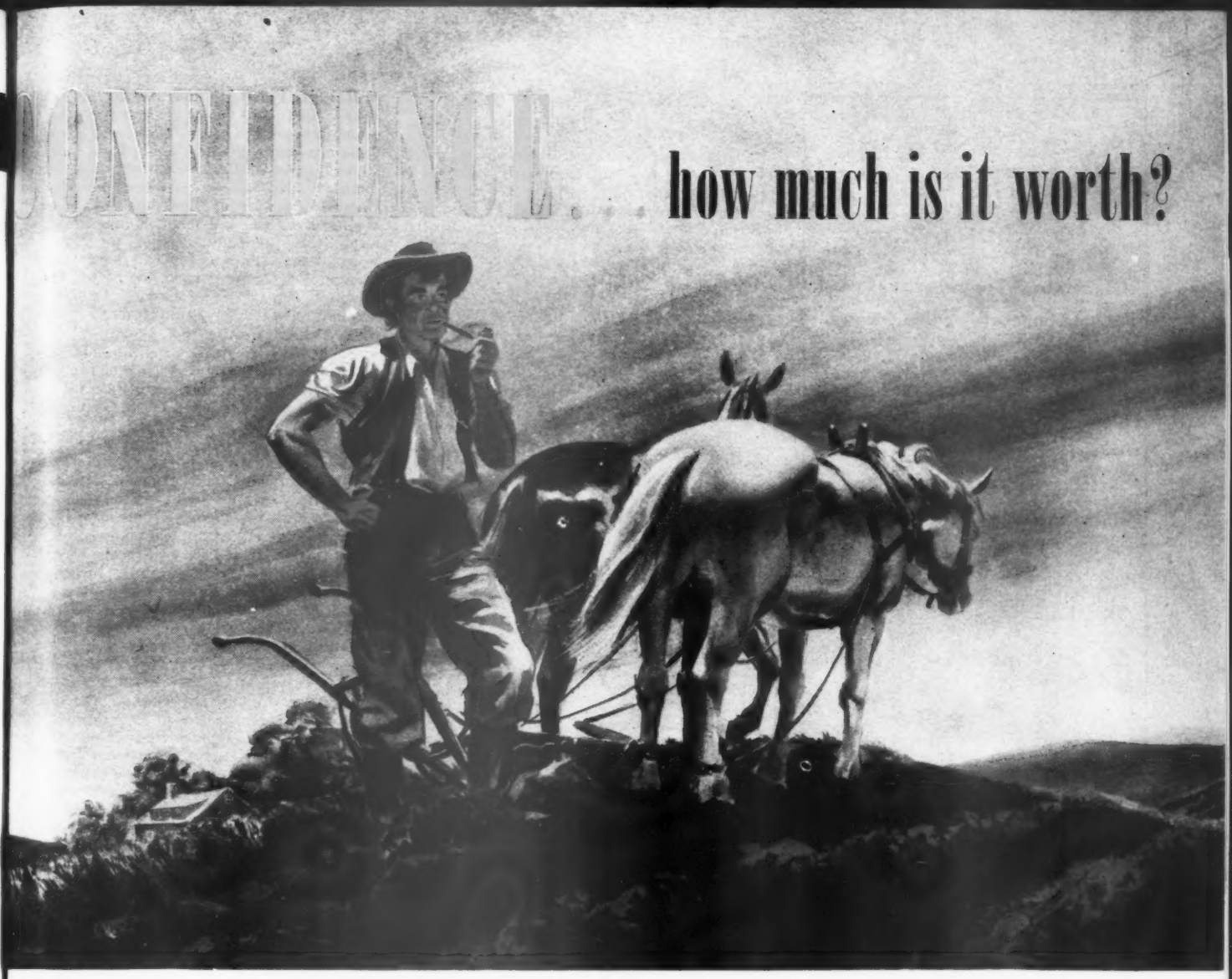
• **Brinton C. Wentz** has been appointed proration engineer for Continental Oil Company, it is announced by **W. C. MacMillan,** vice president in charge of production and drilling. Wentz, who has been assistant proration engineer for the last ten months, succeeds **Charles R. Allen,** who recently was made California region manager of Continental's production department.

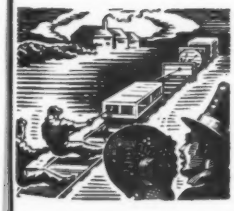
Brinton C. Wentz

• **Wiley Butler,** formerly vice president, has been elected president of the Coastal Oil Company, Newark, New Jersey, effective January 2. **Louis E. Marron,** formerly president, has become chairman of the board of directors.

• **Carl C. Wimberley,** Oklahoma district manager for Lucey Products Corporation, with offices at 501 First National Bank Building, Oklahoma City, announces the appointment of **Verl T. Metz** as assistant district manager for Oklahoma. Metz makes his headquarters at the Oklahoma City office. **Delbert M. Hadden** has been named store manager of the Oklahoma City branch store.

CONFIDENCE . . . how much is it worth?





IN 1841, two years before the first telegraph line was installed in this country, and when there were but 27 states in the Union, John August Roebling was inspired with the idea of making a new kind of rope of unheard of strength and flexibility. His confidence in his idea caused him to risk everything he had on the development of his new rope.

How much is his confidence worth to Industry today, which couldn't turn a wheel without the modern wire rope?

Today, the John A. Roebling's Sons Company invests much time, effort and money in the development of improved products to keep alive the confidence of its many customers.

Roebling values this confidence as its greatest asset. That's why it offers you the greatest value for every dollar you invest . . . in *any* Roebling product.

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Every Roebling Field Engineer has a thorough knowledge of wire rope . . . its types, its uses, its features and limitations. This knowledge plus the experience he gains in his daily contacts can be a great asset to you . . . helping you to solve those tough wire rope problems . . . giving you more service for each wire rope dollar.

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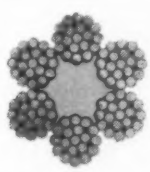

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• **David FitzGerald,** manager of employe relations for the plastics divisions of the General Electric Company, died recently at his home after an illness of several months. FitzGerald had been associated with the General Electric Company for 25 years. He entered the employ of General Electric in Schenectady in 1921 as clerk in the disbursements section of the accounting department. In 1925 he was promoted to the corporate accounts and the following year became one of the company's traveling auditors. After serving in that capacity for eight years he was appointed auditor for the plastics department with headquarters in this city.

In 1940, FitzGerald was named assistant to the manager of the plastics divisions and in May of last year was made manager of employe relations.

• **D. W. Drummond** and **Arthur T. Bennett** have been made vice presidents of The Mathieson Alkali Works, it is announced by **George W. Dolan,** president. Drummond's new title will be vice president-general manager of sales and Bennett's, vice president-general manager of operations.

• **E. T. Adams,** representative of Kerotest Manufacturing Company, Pittsburgh, Pennsylvania, recently returned from an extensive tour of the oil fields of South America, and reports remarkable developments and progress made by major oil companies. Adams' tour was principally concentrated on the countries of Colombia, Peru, Ecuador, Venezuela, and Trinidad.

E. T. Adams

• **W. E. Leroux,** division engineer for The Carter Oil Company's Central division at Seminole, Oklahoma, has been named assistant to the production manager for Carter, with headquarters in Tulsa. Leroux was with Carter in the Seminole area from 1933 until August, 1938, when he went to Europe with the European Gas and Electric Company. He returned in June, 1941, was with Carter at Jena, Arkansas, for four years, then transferred to the Northwest division at Billings before returning to Seminole two years ago. He is a graduate of Notre Dame university and is the son of E. H. Leroux, Tulsa, formerly president of the Oklahoma Pipe Line Company.

J. L. Rogers, district engineer for Carter in the Dix district of Illinois, has been transferred to Seminole to become division engineer of the Central division. Rogers, an Oklahoma A. and M. college graduate, has been with Carter since 1935, serving in Seminole and Illinois.

James Kelley, engineer in the Eastern division, has been appointed to succeed Rogers. He served with a Standard Oil Company (New Jersey) affiliate in Venezuela from 1937 to 1943 and has been with Carter in Illinois since 1943. He is a graduate of Texas Tech.

• **Leland Olds,** at a recent meeting of the Federal Power Commission, asked to be relieved of the chairmanship of that body, a responsibility he has had almost continuously for the last seven years. In accepting Olds' resignation, effective December 31, the commission adopted an expression of its appreciation of his services in that post. The commission then elected as chairman, **Nelson Lee Smith** of Hopkinton, New Hampshire, and as vice chairman, **Richard Sachse** of Fall Brook, California, effective January 1.

• **Roy H. Laird,** oil operator in the East Texas oilfield and mayor of the eastern representative town, Kilgore, Texas, was among those present at the first "Little Rose Bowl" football game at Pasadena, California, December 7. He had as his guests **Fletcher Bowron,** mayor of Los Angeles; **Guy Wadsworth,** vice president, Southern California Gas Company; **Elmer de Maris,** assistant manager geological department, General Petroleum Corporation; **Phil McConnell,** manager of production American-Arabian Oil Company, and **Howard Tinkham,** *Oil and Gas Journal.*

• **S. D. Whiteman,** president of the Kansas-Nebraska Natural Gas Company, Hastings, Nebraska, announces that **Vic E. Baum** has been appointed to the position of assistant to the president.

In Baum's first assignment he will be at Scott City, Kansas, and will coordinate all drilling, producing, and operating activities in southwestern and south central Kansas. Baum recently resigned as president of Bace Oil Company of Wichita, Kansas.

• **Laurence B. Levi,** a director of the Socony-Vacuum Oil Company, Inc., and chairman of its foreign trade committee, retired December 31 after 48 years' service with the company. Levi began work as an office boy in the foreign trade department of the Standard Oil Company at a salary of $3.35 a week. He rose through various positions in the foreign marketing operations of the company and in 1911 he joined the Vacuum Oil Company. He became chairman of Vacuum's export department and in 1931 wes elected a director of the company.

Later in 1931, when Vacuum and Socony merged, he continued as a member of the export department and in 1939 was elected to Socony-Vacuum board of directors.

• **V. J. Rauer, G. M. Patton,** and **R. G. Mussen** have been named to supervisory manufacturing positions in the metallurgy division of the General Electric Chemical Department, it is announced by **A. B. Wellborn,** superintendent of that division.

Rauer was named supervisor of production, Patton supervisor of planning and wage rate, and Mussen, supervisor of test and inspection.

At the same time Wellborn named **J. C. Morrison** assistant general foreman and **R. L. Beilhart, P. J. Moola, J. F. Pickert, E. A. Rees,** and **J. H. Yeomans,** foremen.

• **Harold Jarvis,** sales engineer of Tulsa, Oklahoma, will move into the Illinois Basin early in January to represent Hale Supply Company and Richmond Chemical Company, both of Tulsa, and Dragon Manufacturing Company, Marietta, Ohio. Jarvis will cover Illinois, Indiana, Michigan, and western Kentucky.

• **Ivan G. Burrell,** superintendent of production in the Bridgeport, Illinois, district for The Ohio Oil Company, became division superintendent of the company's Marshall division effective January 1. Announcement of his promotion was made from the company's general offices, Findlay, by **W. B. Emery,** vice president and manager of production for Ohio.

Ivan G. Burrell

Burrell takes over the post formerly held by **A. J. Rosenlieb,** who was recently advanced to division manager at Marshall, Illinois, succeeding the late **C. C. Carroll.** The Marshall division embraces The Ohio Oil Company's producing operations in Illinois and Indiana.

• **A. C. Fetzer,** vice president, has been elected to the board of directors of Mack Manufacturing Corporation. Fetzer, who was acting general sales manager, was at the same time appointed general sales manager.

• **Harry R. Carpenter,** well-known in the oil fields of Oklahoma, Kansas, and Texas because of his 33 years' employment in the industry, has become special sales representative of The National Supply Company in the Midwest Division, according to **A. W. McKinney,** vice president and general manager of sales of the company. Carpenter was formerly division manager of the Jareki Manufacturing Company. His office will continue to be in Bartlesville, Oklahoma, where he has made his headquarters since 1915.

Harry R. Carpenter

• **Dr. Cecil L. Brown,** director of the Esso Laboratories of the Standard Oil Company of Louisiana, Baton Rouge, has been elected a councilor-at-large of the American Chemical Society. Dr. Brown, a former chairman of the society's division of petroleum chemistry, will serve three years on the council, the society's advisory body on policy and general management. He represented the Baton Rouge section of the society as a councilor in 1941 and 1942.

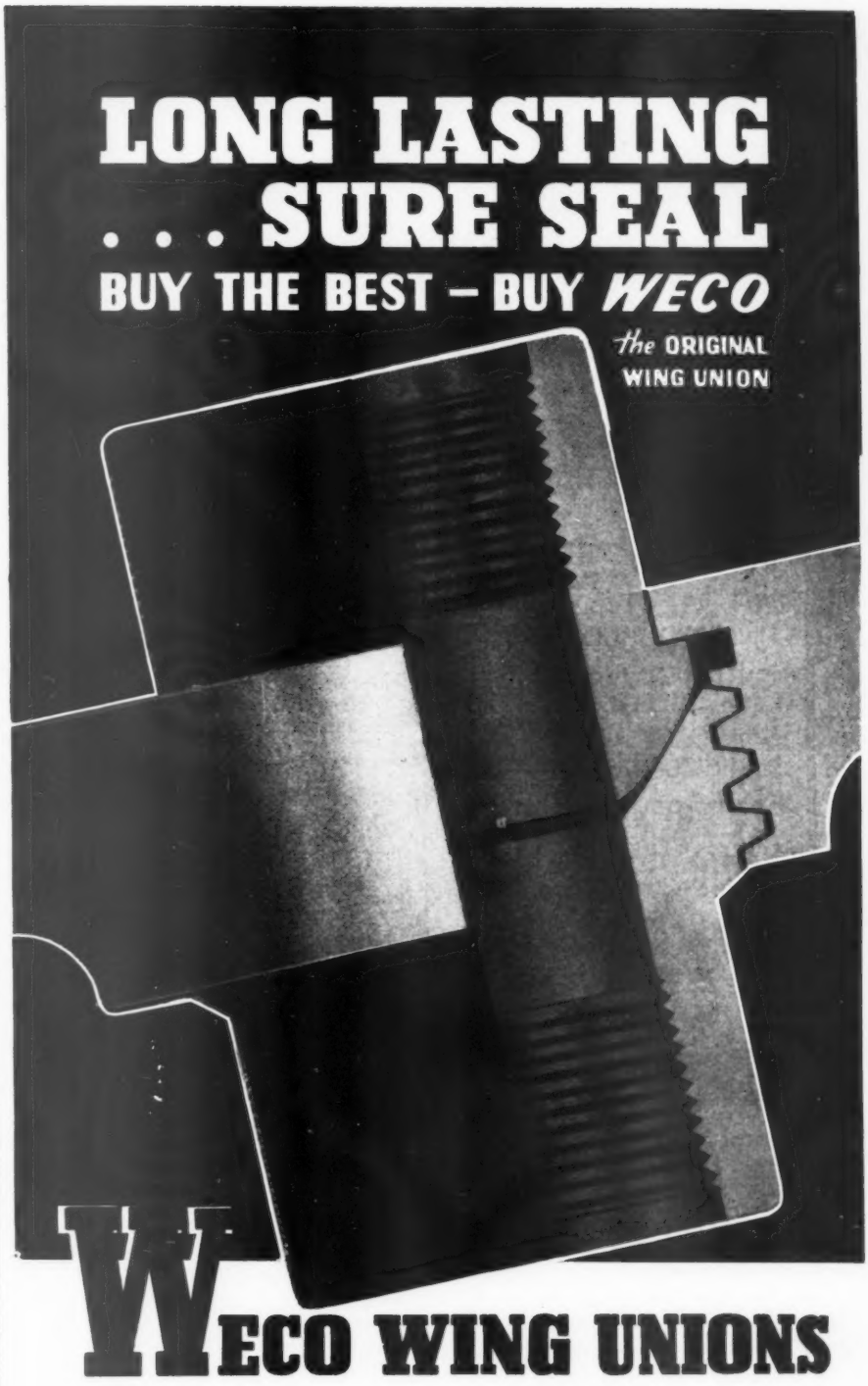
• **Joe C. Kahl,** Northwest division chief scout for The Carter Oil Company at Billings, Montana, has been named chief scout for Carter, with headquarters in Tulsa. At the same time, appointments of **Harry C. Chapman,** Carter attorney at Billings, as assistant manager of the Northwest division; **John O. Campbell, Jr.,** Tulsa, formerly chief scout, as assistant to the manager of the Northwest division, and **A. L. Deaton,** legal department, Tulsa, to the Carter legal staff in Billings, were revealed. The changes are effective immediately.

• **Joseph D. Peeler,** a resident of Los Angeles, has been elected a director of Tide Water Associated Oil Company. Peeler is a member of the law firm of Miller, Chevalier, Peeler and Wilson, of Los Angeles, and a member of the law firm of Miller and Chevalier, of Washington, D. C. He served as an officer in the Air Corps in both World Wars I and II.

• **Robert E. Nagel** has been elected vice president of Benson and Associates, Inc., an organization composed of a group of technologists specializing in industrial accident prevention engineering through analysis, research, development, design, and sale of all types of safety and fire fighting equipment. Prior to his connection with Benson and Associates, Inc., Nagel was associated with Universal Oil Products Company for 25 years as an engineer, and until recently as district sales manager in the New York office of The Fluor Corporation, Ltd.

• **Ernest E. George** has been appointed engineer of the metallurgy division of the General Electric chemical department, according to an announcement by **Robert O. Bullard,** engineering and manufacturing manager of the division.

George is a graduate of Princeton University in the class of 1931 and joined the General Electric Company on the test course in 1933. He was associated with the Schenectady Works laboratory from 1935 until 1945 when he became a member of the carbon products engineering division.



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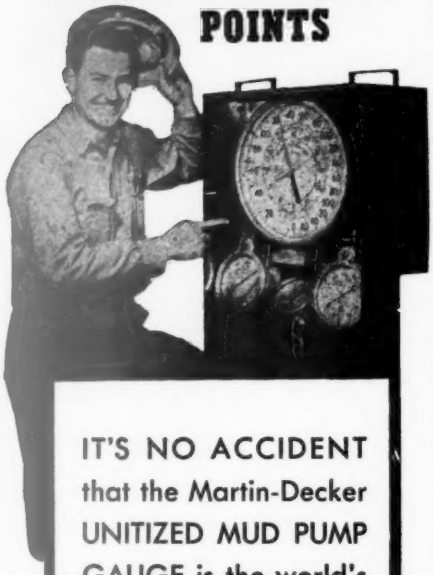

IT'S NO ACCIDENT that the Martin-Decker UNITIZED MUD PUMP GAUGE is the world's finest, most sensitive and rugged instrument for measuring slush pump pressure. The oil industry's leading weight recording measurement and control concern devoted years of development work to combining a special indicating gauge, a patented diaphragm unit, and a built-in pulsation damper in one unitized instrument requiring no tubings or fittings for connection. And best of all, it can be moved from location to location on a moment's notice.

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LAUGH WITH BARNEY

"Does you take this woman for your lawfully wedded wife?" asked the Negro minister of an undersize, bowlegged, watery-eyed shrimp of a man standing up beside 200 pounds of feminine assurance.

"Ah takes nothin'," responded the little man gloomily. "Ah's bein' took."

* * *

The Boss: He's the fellow who's at the office early when you're late, and late when you're early.

* * *

If, as the newspapers would have us believe, all brides are beautiful, where in Sam Hill do all the homely married women come from?

* * *

Bridegroom: This steak has a queer taste.
Bride: I can't understand it. I burned it a little, but I immediately rubbed it with vaseline.

* * *

MacTavish: I smoke quarter cigars!
O'Flarity: Yeah, who smokes the first three-quarters?

* * *

He: My love cannot be expressed in words.
She: Well, tell me about it!

* * *

Manager to models: Now, girls, remember when you sit down, assume the 'Prodigal Pose'—that's the one that brings out the fatted calf.

* * *

First Hobo: (Surveying stream of pleasure seekers): I hate holidays.
Second Hobo: Yes, makes yer feel common when nobody ain't workin.

* * *

The Scotch remedy for seasickness is a simple one—just hold a quarter between your teeth.

* * *

"My husband is one man in a hundred."

"How do you manage to keep him from knowing it?"

* * *

Willie Johnson, a sawed-off, beaten down little man, was arraigned in a Texas court on a felony charge.

The clerk intoned: "The State of Texas versus Willie Johnson!"

Before he could read further, Willie almost broke up the meeting by solemnly declaring: "Lawd! What a majority!"

* * *

"Hello, Henry," a Birmingham darky called out to a friend he had not seen for several months, "how's everything?"

"Ain't you heard, Joe?" Henry replied. "I'se been divorced."

"Do tell!" said Joe. "What did you and your woman do wit dat house you-all owned?"

"Oh, we divided it up."

"Divided yo house?" rejoined Joe, looking slightly puzzled. "How?"

"Fifty-fifty!" said Henry. "She takes de inside an' I takes de outside."

* * *

"Say, pop, did you go to Sunday school when you were a little boy?"

"Yes, son—regularly!"

"I'll bet it won't do me any good either."

* * *

Monday noon, at the YWCA, the Engineering club of Oklahoma City will hear Tony Baloney discuss "Proper Control of Horsepower in Reaching for the Lunch Check."—Daily Oklahoman

Mike Clancy had been working on New York harbor tugboats for fifty years when he fell overboard and was drowned. This brought about a very fine wake, at which the highest praise was given the deceased and all the traditional ceremonies were observed.

During the proceedings, a friend of the widow asked her: "Did Mike leave you well fixed?"

"Shure, an' he did that. 'Tis fifty thousand he's after leavin' me."

The friend rolled her eyes heavenward. "Tch tch tch," she said. "Think of that. And him that couldn't read nor write."

"Yes," agreed the widow, shaking her head seriously, "nor swim."

* * *

"Now, dear," said the visitor, "if your mother gave you a large apple and a small apple and told you to give one to your brother, which would you give him?"

"Do you mean my big brother, or my little one?"

* * *

A new girl on the farm was an interested observer of some newly-hatched chicks.

Finally she said: "I can see very well how they got out of their shell, but for the life of me I can't see how they got in!"

* * *

A fellow was dragged from his wrecked car and taken to a nearby house. "I can't help you," said the householder, "I'm not an M. D., but a veterinarian."

"You're just the fellow for me," said the injured man, "because I was a jackass to think I could do fifty with those thin tires."

* * *

A man entered a saloon and ordered a straight shot which the bartender served in the usual manner. Holding his nose, the visitor gulped down the drink. Thinking this rather peculiar, after the man had done it several times, the bartender asked him why he drank the stuff if he didn't like the smell. The other replied: "It isn't that I don't like the smell of it; it's just that I am afraid if I smell the stuff my mouth will start to water and I will dilute it before I can drink it."

* * *

A man got up early one Sunday morning to let the iceman in. Being unable to find his bathrobe, he slipped on his wife's kimono. When he opened the door, he was instantly greeted by a nice big kiss from the iceman. And the only way the first fellow could figure it out was that the iceman's wife had a kimono just like the one he had on.

* * *

A six-year-old was taken to church for the first time. After she returned home her uncle asked her how she liked church. She answered. "I liked the music okay but the commercial was too long."

* * *

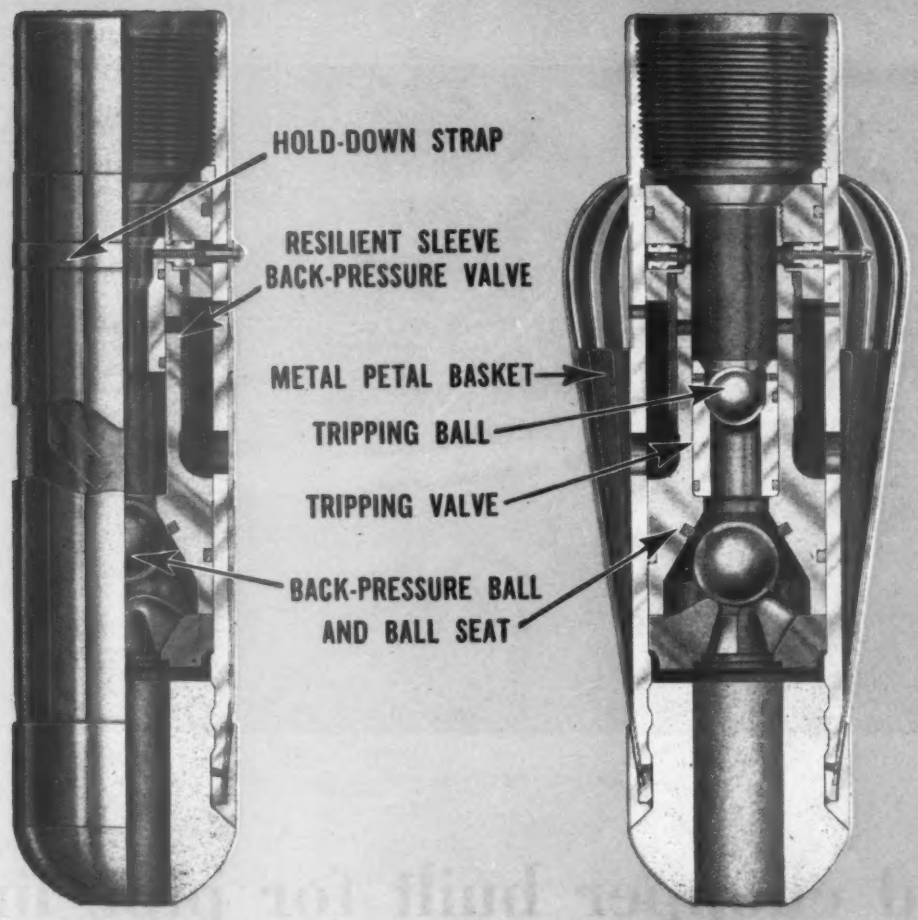
A rich old aunt was paying her nephew's college expenses and her visitor asked her if it were expensive.

"Well," said the aunt, "some of the languages run pretty high. My check this month covered $10 for Chemistry, $20 for Latin, and $250 for Scotch."

* * *

The Young Man: What time is it getting to be?

The Young Lady: "I don't know, but it was Saturday night when you came.



THE BAKER *Triplex* CEMENTING SHOE does an important job...and does it well!

The "Triple" purpose of the Baker TRIPLEX Cementing Shoe is to pack-off in large-diameter, or irregularly-shaped holes, retain all cement slurry above the shoe, and protect permeable, low-pressure formations below from cement contamination.

All cement slurry is directed upward through side whirler ports. A sleeve-type, resilient rubber back-pressure valve opens readily to permit passage of the slurry into the annulus around the shoe, but closes instantly to prevent any return flow of slurry. The Baker Metal Petal Basket is intended to form a bridge, thus preventing cement slurry from settling into permeable, low-pressure zones below. The Basket is indispensable in large-diameter, or irregular-shaped holes.

The Baker TRIPLEX Cementing Shoe (Product No. 136) operates as a conventional float shoe while running-in the casing. Then, after reaching the desired point in the hole, circulation is established through the ample interior passageway of the shoe, and the hole is conditioned preparatory to cementing. The Tripping Ball now is pumped (or allowed to gravitate) down the hole to seat upon the Tripping Valve. A pressure of 400 to 500 psi is applied to the casing which shears the screws in the Tripping Valve, permitting it to move downward and expose the cementing ports. Shearing these screws also releases the hold-down strap around the basket, allowing the basket to expand outwardly against the wall of the hole. The cementing operation is then carried out in the conventional manner with all cement slurry directed upward and held above the shoe by the expanded Baker Metal Petal Basket.

The Baker TRIPLEX Cementing Shoe consists of a whirler float shoe with a Baker Metal Petal Basket fastened on the shoe below the cementing ports. All internal parts are made of readily drillable materials. Two one-half inch set screws hold the inner assembly stationary to facilitate drilling out the shoe.

Contact your nearest Baker office or representative for details and recommendations.

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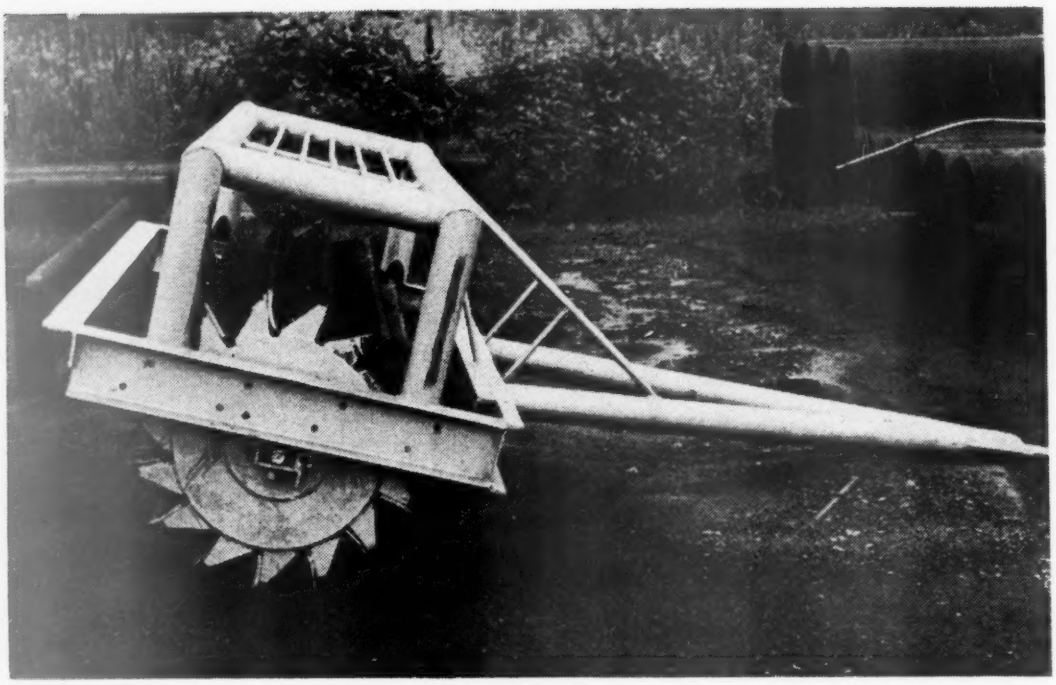


Side view of the right-of-way weed and brush cutter, which shows the framework and blade circle. Below is a front view of weed chopper.

Weed chopper built for pipe line work

By **O. C. IRVINE**

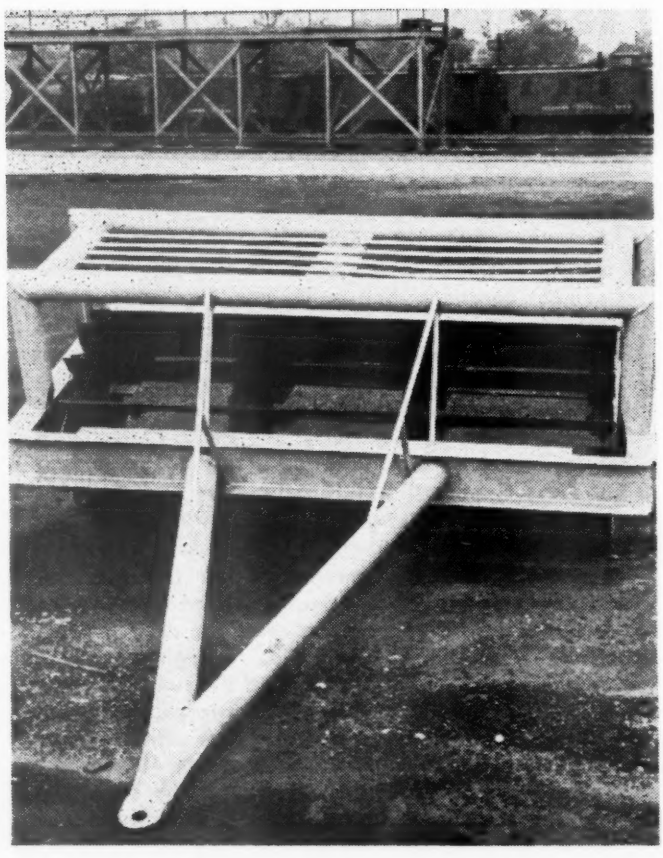
United Gas Pipe Line Company

WEEDS grow high along pipe-line rights-of-way in many sections of United Gas Pipe Line Company's Jackson, Mississippi, district. They grow much too fast for bank blades and other hand tools unless maintenance crews keep eternally after them.

EXCLUSIVE To ease the endless battle of the weeds, pipeliner ingenuity resulted in the weed and brush cutter pictured here in two views. Constructed by crewmen of the district, the weed cutter has undergone successful try-outs and holds much promise as an aid in keeping pipe-line routes clear of undergrowth.

Weighing approximately 2000 lb. and so constructed that additional weight can be added when necessary, the right-of-way cutter has fifteen 6-ft.-long blades, ½ in. thick by 6 in. wide, and spaced 8 in. apart. Diameter of the blade circle is 34 in. With an overall height of 50 in. and length of 8 ft., it is equipped with tongue and coupling for hitching to tractor or team.

Found particularly effective in dry weather, according to E. W. Thompson, section foreman at Jackson, the machine's cost of construction was nominal. ★★★



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By PARK J. JONES, *Consulting Engineer, Houston, Texas*

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By V. A. KALICHEVSKY

A simple, non-technical description of petroleum and its preparation. Explains the nature and composition of petroleum; refining and distillation; cracking methods; its location, extraction and transportation.

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New drilling firm

An example of free enterprise in its most effective form is the formation of a new organization, the Santa Fe Drilling Company, with an authorized capital stock of $500,000, which will go into operation as a completely independent drilling contractor on February 1,1947. The stockholders of this unique concern are some 65 former employees of Union Oil Company of California, who have purchased outright from Union all of its drilling facilities. It is especially emphasized that Union has no subsidiary interest whatever in the new company, and that the latter is wholly owned by the aforementioned stockholders.

Officers of the Santa Fe Drilling Company are J. D. Robinson, president; R. A. Powell, secretary-treasurer; with H. P. Wickersham, Frank Goss, Howard Robinson, Leo Goss, and Kent Garner completing the board of directors. These men have been chosen to their respective offices because of long experience and recognized talent in some important phase of drilling

R. A. Powell

J. D. Robinson

operation. Joe Robinson was general drilling superintendent for Union Oil Company prior to the formation of the drilling organization; R. A. Powell was an accountant; H. P. Wickersham was chief mechanical engineer; Frank Goss was district drilling foreman, Coast Division; Howard Robinson was district drilling foreman, Southern Division; Leo Goss district drilling foreman, Valley Division, and Kent Garner an experienced driller.

The new company will start out with complete facilities, including drilling equipment; the necessary cars, trucks and mobile units; office buildings, warehouses, tool racks, etc., and will operate ten strings of tools and two strings of repair tools. Operations in the initial stages will cover the western states, but will not necessarily be confined to any sectional, or even domestic area.

In addition to drilling and well repair work, Santa Fe Drilling Company is set up to provide oil field mechanical engineering service, and will also offer service on mud control and the problems related thereto. Headquarters are at Santa Fe Springs, California, at the Junction of Santa Fe Springs Road and Los Nietos, where a considerable portion of the existing Union Oil Company field quarters has been purchased as part of the total agreement. The postal address of the firm is Box 415, Santa Fe Springs, California.

Short course dates

Representatives of the natural gas industry from 12 states attended a general committee meeting of the Southwestern Gas Measurement Short Course in Houston, Texas, recently. R. M. Scofield of the Lone Star Gas Company, Dallas, general chairman, presided. The dates of May 6, 7, and 8, were set for holding the 1947 school to be held at the University of Oklahoma.

Other business of the meeting included the election of committee chairmen and action on recommendations of the executive committee. Committee chairmen elected were as follows: Program commitee, E. C. McAninch, Oklahoma Natural Gas Company, Ardmore, Oklahoma; publications committee, W. H. Woods, Gulf Oil Corporation, Houston, Texas; exhibits committee, George E. Greiner, Phillips Petroleum Company, Bartlesville, Oklahoma; practical methods committee, chairman: B. F. Worley, United Gas Corporation, Houston, Texas, and vice chairman: J. L. Griffin, Northern Natural Gas Company, Omaha, Nebraska; registration and publicity committee, Miss Kate A. Niblack, Oklahoma Utilities Association, Oklahoma City; and local arrangements committee, W. H. Carson, dean, College of Engineering, University of Oklahoma, Norman, Oklahoma.

President S.A.E.

Election of C. E. Frudden, of the Tractor Division, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, as the 1947 president of the Society of Automotive Engineers was announced January 7 at the business session of the SAE 1947 Annual Meeting in Book-Cadillac Hotel at Detroit, Michigan President-elect Frudden succeeds L. Ray Buckendale, of Timken-Detroit Axel Company, Detroit, who served for 1946.

Statement of the Ownership, Management, Circulation, etc., Required by the Acts of Congress of August 24, 1912, and March 3, 1933, of

THE PETROLEUM ENGINEER

Published monthly at Dallas, Texas for October 1, 1946.

State of Texas, County of Dallas, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared W. T. Bryan, who, having been duly sworn according to law, deposes and says that he is the Business Manager of

THE PETROLEUM ENGINEER

and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: The Petroleum Engineer Publishing Co., P.O. Box 1589, Dallas, Texas.

Editor: K. C. Sclater, P.O. Box 1589, Dallas, Texas.

Managing Editor: F. H. Love, P.O. Box 1589, Dallas, Texas.

Business Manager: W. T. Bryan, P.O. Box 1589, Dallas, Texas.

Advertising Manager: T. J. Crowley, P.O. Box 1589, Dallas, Texas.

2. That the owner is a partnership composed of W. T. Bryan, T. J. Crowley, W. L. Love and K. C. Sclater, all of Dallas, Texas, doing business under the name of The Petroleum Engineer Publishing Company.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has an interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

W. T. Bryan, Business Manager.

Sworn to and subscribed before me this 24th day of September, 1946.

[Seal] Lillian H. Johnston

(My commission expires June 30, 1947.)

Sales management changes

Preparatory to inaugurating an enlarged sales and engineering program in Texas and the Mid-Continent, Kobe, Incorporated, has made shifts in personnel involving two of its key managers. M. L. Walraven, Jr., formerly sales manager of the northern districts, which includes Oklahoma, Kansas, Nebraska and Illinois, goes to Dallas as southern area sales manager. He is one of the oldest members of Kobe's sales staff, having been with the company since 1933. In his new position,

M. L. Walraven, Jr.

Harry Wilson

Walraven will be responsible for the company's field sales and technical activities in Texas, Louisiana, Arkansas, and New Mexico.

Harry W. Wilson, who joined Kobe as a member of the service staff in 1937, has been promoted to northern area sales manager, replacing Walraven. His headquarters will be at Tulsa. He has represented Kobe in the Oklahoma district as manager since 1941.

Both Wilson and Walraven will continue to operate under the direction of R. G. Ralph, division manager in Oklahoma City.

L. A. Nomads' party

With Bill and Mrs. Bettis doing honors as host and hostess for the Los Angeles Nomads, a goodly representation of members, visitors, and friends of the press, with their ladies, gathered at the Royal Palms Hotel on Saturday, December 7, and disported with a fairish measure of abandon, until the night turned to a pale gray, and the local milkmen took over.

Following an enjoyable buffet supper, which was attacked voraciously by Larry Coker, Johnny Shea, and several press men who shall be nameless, Bill Bettis officiated as a somewhat dainty Santa Claus, with no whiskers and no bulging waistline, and distributed gifts with a lavish hand to all and sundry.

Meantime, Hal Coops of Patterson-Ballagh Company. in his new role as photographer elect, exploded flash bulbs all over the place, giving the affair the brilliance and luminance of a Hollywood premiere. As a matter of fact, there were at least two Warner Brothers' starlets present to lend reality to the Hollywood illusion, and there was plenty of nonhistrionic beauty, too, to add to the glamor of the occasion.

Several visitors from the Near East and Europe came along escorted by Mr. and Mrs. Henry Pullman, who have probably entertained more foreign guests over the years than any other couple in Los Angeles. In any case, there were enough emissaries from other oil producing countries on hand to yield the typical international flavor for which the Nomad parties are famous. In every respect it was a success, and as usual generous credit must be given to Wally Sawdon, without whom, it would seem, no meeting of the Los Angeles chapter would be quite complete.

The conventional oil well with its single vertical hole is handicapped all its life. It is cheating you of full production. Oil must channel through the surrounding sand at high velocity. But by drilling horizontal drain holes at the time the vertical hole is completed, you open a multitude of *slow velocity* drains at minimum cost. Excess sand and gas are eliminated. The oil travels along wide unrestricted avenues instead of squirming through limited areas. You maintain the right control of the sands for the prolonged life of your well. Learn more about horizontal drilling. Write.

New descriptive bulletin upon request.

TURBINE BIT COMPANY

(Under the ownership of John A. Zublin)

2369 E. 51st St. (Phones: JE. 4433, JE. 6151) Los Angeles 11, Calif.

Made Fluor directors

T. H. "Ted" Seavey, manager of purchases, and J. R. "Bob" Fluor, manager of manufacturing, have been appointed directors of The Fluor Corporation, Ltd. Seavey has been with the firm since 1931, and Fluor, who was an Army Air Force pilot during the war, rejoined the company last June.

J. R. Fluor

T. H. Seavey

R. M. Dinges dies

R. M. Dinges, vice president of The Continental Supply Company in charge of the New York office and foreign operations, died December 31 in New York City.

R. M. Dinges

Dinges joined the Continental organization 24 years ago as a floor man at Virgil, Kansas. In 1927 he was transferred to the company's foreign division and, at various times, was a representative in Venezuela, Roumania, and London, England. His service with Continental was uninterrupted except for a period during the war when he was on leave of absence as an executive with the Petroleum Administration for War.

Dinges had been a Continental vice president in charge of foreign operations since May 15, 1945.

Langley S.A. representative

Announcement has been made by Harry E. Hester, export manager of the McCullough Tool Company, of the appointment of Kenneth J. Langley as exclusive representative for the sale of McCullough products for Argentina, Brazil, Paraguay, Bolivia, Uruguay, and Chile.

Langley has had many years' oil field experience and recently has been associated with one of the large oil publications in the capacity of eastern manager. Langley is, at present, in New York and expects to leave shortly for Buenos Aires, Argentina, where he will make his headquarters.

Name changed

Effective January 2, 1947, the Petroleum Equipment Company, a wholly owned subsidiary of Bethlehem Pacific Coast Steel Corporation, will be known as the Bethlehem Supply Company of California. The announcement was made by H. H. Fuller, president of both companies.

For 25 years, the Petroleum Equipment Company has been one of the leaders in its field of serving the California oil industry. The company was purchased by Bethlehem Steel Company in February, 1945, and was taken over by Bethlehem Pacific in May, 1946.

Under the new name of Bethlehem Supply Company of California, the organization will soon announce plans for extensive expansions and improvements which will offer even greater service to the oil industry.

G. W. Schweinhard, vice president and general manager, Wendell M. Jones, vice president, and other personnel of the company will continue in the same capacities under the new name.

Welding awards

The 1945-46 Samuel Wylie Miller Memorial Medal, the prizes of the Resistance Welder Manufacturers Association, the 1946 Lincoln Gold Medal, and the 1946 A. F. Davis Undergraduate Welding Awards, were presented at the annual banquet of the American Welding Society at its 27th annual meeting, Ambassador Hotel, Atlantic City, New Jersey.

Award of the Samuel Wylie Miller Memorial Medal was made to James F. Lincoln, president of The Lincoln Electric Company, Cleveland, "whose belief in the value of electric arc welding has led him to most effective promotions of its use."

Julius Heuschkel, research engineer, Westinghouse Research Laboratories, East Pittsburgh, Pennsylvania, was awarded the $750 first prize in the 1946 Resistance Welder Manufacturers' Association Prize Contest. This award was made for Heuschkel's paper entitled, "Selecting Spot Welding Schedules for Low Carbon Steels."

Joseph J. Riley, sales engineer, Taylor-Winfield Corporation, received the second prize of $500 for his paper on "Vibration of Spot Welds in Low Carbon Steel Over A Range of Welding Variables."

The third award of $250 went to Robert W. Bennett and Robert D. Williams, authors of the paper entitled, "The Flash Welding of Hard Drawn High Carbon Steel Wire."

The Lincoln Gold Medal, presented annually by the American Welding Society since 1936, was awarded to H. E. Kennedy for his paper, "Some Causes of Brittle Failures in Welded Mild Steel Structures."

Recipients of the A. F. Davis Undergraduate Welding Awards were Stephen Mikochik and Joseph S. Ward, Jr., whose first-prize paper appeared in the *Manhattan Engineer*, Manhattan College, New York City, and Lee Ragsdale, Jr., whose award paper appeared in the *Dukengineer*, Duke University, Durham, North Carolina.

To Middle East

Technical Oil Corporation's foreign representative, P. T. Bannerman, who recently returned from a trip covering all oil producing countries of South and Central America, leaves for the Middle East shortly after the first of the year.

P. T. Bannerman

Bannerman's trip will extend the services of a factory-trained field engineer to the users of Totco equipment and those interested in the latest developments and techniques in controlled vertical drilling, into the oil fileds of Europe as well as those of the Near and Middle East.

Tank firm purchased

Graver Tank and Manufacturing Company, East Chicago, Indiana, and Banks Moreland of Houston, Texas, have jointly announced that Banks Moreland's tank business, which formerly was conducted under the name Banks Moreland Company, has been purchased by Graver and will continue to operate in the Southwest as Banks Moreland Company, a division of Graver Tank and Manufacturing Company, Inc. The new division is under the management of Banks Moreland, who has been made a vice president of Graver.

Heads department

Joseph R. McGilvray, associated with Westinghouse for 22 years, has been named manager of the Westinghouse Electric Corporation's manufacturing and repair department, Pacific Coast district, Emeryville, California. Word of McGilvray's appointment was received here from Harry F. Boe of Pittsburgh, Pennsylvania, vice-president in charge of the department nationally.

McGilvray will head activities of his department throughout an area comprising all or parts of nine far western states, Alaska, and Hawaii. In addition to the district headquarters plant at Emeryville, four other plants are located in the area—at Los Angeles, Portland, Seattle, and Salt Lake City.

Sales and engineering conference

Substantial expansion in the fields of oil and gas equipment was forecast at the annual sales and engineering conference of member companies of Dresser Industries, Inc., held at Edgewater Beach Hotel, Chicago. Shown with J. B. O'Connor, executive vice president of Dresser Industries, are (left) John Avery, president and general manager of Roots-Connersville Blower Corporation, Connersville, Indiana, and (right) Eric Flaschar, general manager of Stacey-Dresser Engineering Division, Cleveland, Ohio.

Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

OUR 27th YEAR

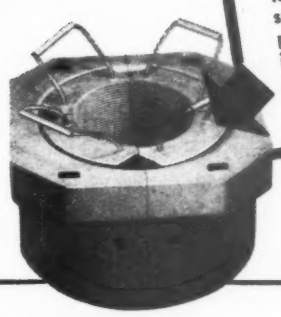
Why not run your casing with the same simplicity, speed and convenience as you do drill pipe?

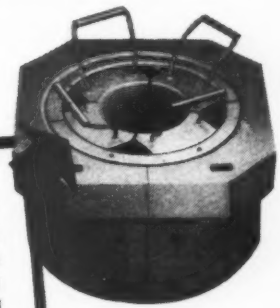
Here's how.. with the BAASH-ROSS SPLIT ROTARY TABLE CASING BUSHING

Did you know that you can run casing jobs with the same ease, convenience and simplicity with which you run your drill pipe? All that you need is a Baash-Ross Split Rotary Table Casing Bushing which replaces the regular master bushings in the rotary table and permits casing to be run *through the table* with the crew working at the same convenient height and in the same efficient manner as when handling drill pipe. Here's all you do...

1 Simply lift out the regular master bushings, drop in the Split Casing Bushing and lock the table. The Split Casing Bushing is thus solidly supported and properly centered over the hole so that you can run casing with the same ease and with the crew working at the same convenient height as when running drill pipe.

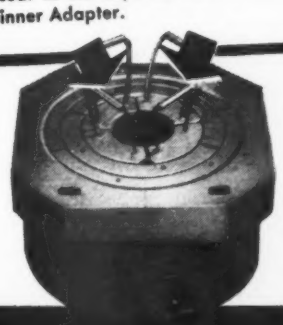
2 For large diameter casing, the Slips seat directly in the bore of the Split Bushing. The extra long internal taper of the Split Bushing permits using long slips having a full-length support and with maximum gripping area. This eliminates crimping or damaging the thin-walled casing through concentration of slip pressure over a small area.





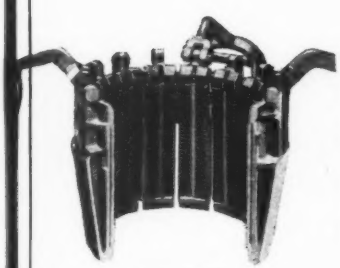
3 For medium sizes of casing, drop in a split and hinged Slip Adapter which is tapered on both sides and sets flush with the top of the Casing Bushing. Slips to fit the casing then seat directly into the split and hinged Adapter.

4 Even the smallest sizes of casing can be run with equal convenience by simply dropping in another concentric split and hinged Adapter, and slips to fit the casing then seat in the tapered bore of the inner Adapter.



Two Types of Slips

Although the above illustrations show the Casing Bushing being used with conventional solid type of slips with flexible handles, the newly-developed Baash-Ross "UC" Casing Slips can also be used. "UC" Casing Slips provide the added safety of maximum gripping efficiency because they consist of many narrow slip segments flexibly linked together that w-r-a-p around the casing for a full-circumferential grip. Also, "UC" Casing Slips have easily renewable liners for long life and economy. (For more details on "UC" Casing Slips see page 276 of the new Composite Catalog).



Type "UC" Casing Slips

Handles Wide Range of Casing Sizes

Modern rotary tables are able to support even the longest and heaviest casing strings with ample safety, and the Split Rotary Table Casing Bushing is ruggedly built to withstand the same service. Yet it is light in weight and readily portable in small tool cars.

The maximum casing size handled by the Casing Bushing is determined by the diameter of the opening through the rotary table. The accompanying chart shows the largest casing size that will pass through the Casing Bushings made for various size rotaries.

Rotary Bore	Maximum Casing Size
27½" Dia.	21½" API
24½" Dia.	18⅝" API
20½" Dia.	16" API
17½" Dia.	13⅜" API

ECOLITE 92BM

WITH LOCKING DEVICE AND SEALS

TWICE APPROVED for DOUBLE SAFETY

APPROVED BY
U. S. BUREAU OF MINES
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—for use in atmospheres containing Methane or natural gas, gasoline or petroleum vapors. This double-safety lantern has a tamper-proof reflector and cover with locking device and seals. Throws 1500 ft. beam. Instantly ejects broken bulbs from battery circuit. Large handle—360° pivoting feature gives direct illumination where needed and leaves both hands free for work.

Now at Supply Stores

ECONOMY ELECTRIC LANTERN CO.
3100 W. CHERRY ST. MILWAUKEE 8, WIS.

LINE SCALES

10 of the 20 Models we manufacture. 40,000 pounds to 500,000 pounds. A special scale for any job.

With a Line Scale you know the pull on the line, and the weight on the bit in pounds. Accurate, sensitive, rugged and economical.

Line Scales are dependable, even in areas of rapid temperature changes. Repeated tests prove the accuracy of Line Scale readings under all working conditions.

See your supply man, now

LINE SCALE CO., INC.
Phone 2-1765, 907-11 SE. 29th Street, Box 4245
OKLAHOMA CITY, OKLAHOMA

Office reorganized

In order to serve its pipe customers in the Philadelphia area better, the Spang-Chalfant Division of The National Supply Company will reorganize its present sub office in the Morris Building as a complete district office, according to an announcement by George E. Clifford, vice president of the company.

William H. Taylor

William H. Taylor, who has been in the Philadelphia sub office since being transferred from Boston four years ago, will be manager of the Philadelphia district. The district will cover eastern Pennsylvania, Maryland, Delaware, southern New Jersey, District of Columbia, Virginia, and eastern North Carolina.

The former sub office was a part of the New York district. The new arrangement will assure speedier handling of customer relationship.

Taylor had been with the sales department of the Central Tube Company since 1930 and joined the Spang-Chalfant Division when the former company was acquired in 1940.

A.P.I. meeting

The regular spring meeting of the Southwestern District API Division of Production will be held on March 27 and 28 at the Blackstone Hotel in Fort Worth, Texas.

The program committee, under the chairmanship of Burt J. Dowd, of the Union Producing Company, Shreveport, Louisiana, is already at work and has several constructive papers in prospect.

Elgin Softener appoints

Chester T. McGill, president and general manager of Elgin Softener Corporation, Elgin, Illinois, has announced the appointment of Elwood W. Scarritt as assistant general manager of the corporation.

Scarritt graduated from the University of Illinois in 1924 with an A. B. degree in science. After his graduation he received an M. S. degree in the field of water purification at the University.

Prior to joining the Elgin staff, Scarritt was connected with the technical staff of the Paige and Jones Chemical Company, where he was in charge of chemical research and special production problems in the field of water conditioning.

In rounding out 20 years' service with the Elgin Softener Corporation he is well qualified for his new duties. He has risen successively from chief chemist, chemical director, and industrial sales manager to his present position. For the present he will continue to act as industrial sales manager in addition to his assistant managerial duties.

In new Tulsa site

The Brown Instrument division of Minneapolis-Honeywell Regulator Company has opened a new branch office at 117 West Eighth Street, Tulsa, Okla., in charge of R. P. Walker, branch manager.

The new location, within a few blocks of Tulsa downtown oil company offices, includes storage space for instrument accessories, supplies and emergency repair stock, permitting the Brown company to render extended maintenance and servicing.

Joins Republic Supply

Announcement has been made by the Republic Supply Company of the appointment of Carl L. Knoll as sales representative with headquarters and office at Bartlesville, Oklahoma. He will work the northern Oklahoma and southeastern Kansas territory from this point, which is under the supervision of J. H. Brooks, vice president and district manager with headquarters at Tulsa.

Carl L. Knoll

Knoll has lived in Bartlesville for a number of years and has been engaged in the oil country supply business since 1920.

New office locations

The Lincoln Electric Company, Cleveland, Ohio, announces new locations of its branch offices in San Francisco, Los Angeles, and Birmingham.

The new location of the San Francisco office and warehouse is at 1302 Stanford Avenue, Emeryville 8, California, under the direction of L. P. Henderson, district manager and welding engineer.

The Los Angeles office and warehouse is now at 1500 Calzona Street, P. O. Box 7336, Station L, Los Angeles 23, California. J. B. McCormick is district manager and welding engineer.

The Birmingham district office has its new location at 113 North Ninth Street, Birmingham, with J. E. Durstine the district manager and welding engineer.

GET ACCURATE RESULTS
Quickly . . Easily . . with
CURTIN CENTRIFUGES

No. 3480. 100 c. c. machine. Cranks and heads interchangeable with 15 c. c. machines.

You can maintain your required speed for the period of the test with much less effort. Curtin centrifuges, proven world-wide, are heavy duty, rigidly constructed, and extremely simple in design. Illustrated bulletin, giving full details, available upon request.

W·H·CURTIN & CO.
DEP'T. "C"
HOUSTON, TEXAS . . . NEW ORLEANS, LA.

Export representative

George Miller, president of Oil Base, Inc., Los Angeles, manufacturer of "Black Magic" oil base drilling mud and chemicals for the petroleum industry, recently announced the appointment of Transamerican Factors, Ltd., as exclusive export representatives for South America, Mexico, and the West Indies.

George Miller

Transamerican Factors, Ltd., with headquarters in Los Angeles and headed by Victor E. Milch, has long been engaged in the export of oil field equipment to Latin America and is in close contact with drilling operaitons in those countries. Dr. Gonzalo Acosta Sarmiento is the resident partner of the firm in charge of Transamerican's regional office in Bogota, Colombia, servicing the west coast countries of Colombia, Ecuador, and Peru. Dr. Hermando Madero Paris heads the company's activities in Venezuela and the West Indies. Offices are being established in Mexico City and Buenos Aires.

Heads steamship company

Election of E. F. Battson, New York, to be president of Continental Steamship Company, Baltimore, a subsidiary of Continental Oil Company, Ponca City, Oklahoma, has been announced.

E. F. Battson

Continental Steamship Company operates a fleet of tankers between the Gulf Coast and the Atlantic Seaboard, with terminals at Lake Charles, Baltimore, Richmond, and Norfolk.

Battson, who is assistant to President Dan Moran, Continental Oil Company, will handle the steamship company assignment in addition to his other duties. He has been associated with Continental for 25 years.

To head Pantepec

C. U. Daniels, general manager in charge of operations of Pantepec Oil Company of Venezuela, C. A., at Caracas, Venezuela, will become president of the company on April 1, 1947, it is announced.

Daniels, a former vice president of Oklahoma Natural Gas Company, will succeed Warren W. Smith, who is retiring from business on April 1 after 23 years with the company.

Continental stores

The latest point to be added to the Continental Supply Company group of stores is McAllen, Texas. The store began operation on January 2. W. O. Bright, formerly with Continental's Sullivan City branch, is manager. The store will be under the supervision of W. G. Fitzpatrick, district manager at Houston.

Continental also announces the opening of a new store at Brookhaven, Mississippi with J. R. Osteen as manager. Osteen was formerly connected with the company's store at Shreveport. This point in the Continental group will be under the supervision of E. N. Wood, district manager at Shreveport.

Service over the years with FORGED STEEL UNIONS

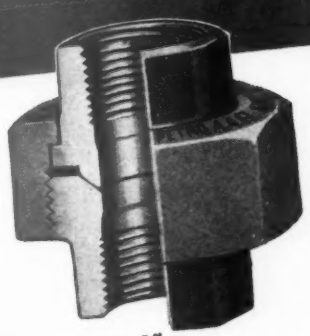
Unions are hot forged from solid round bars of high quality Open Hearth Forging Steel.

Handle-Bar

Hi-Speed Handle-Bar Unions with integral steel to steel seats, or completely fused bronze to bronze seats, black or Udylite (cadmium plated) — sizes from ⅜" to 4" inclusive in 4000 test, sizes 2" to 4" inclusive in 6000 test.

4000 Test Unions furnished with Briggs Standard steam threads in pipe ends, whereas the 6000 Test Union has long pipe ends with API line pipe threads. Nut threads are modified Acme to facilitate easy and speedy assembly and disassembly. Seat design is a 45 degree cone, machined and cold rolled, to a ball seat on male end. Handle-Bar Unions are recommended for all services where they are made up and taken down frequently.

Petro



Sizes ⅛" to 3"

PETRO unions have integral steel to steel seats. Made to A. A. R. design. 600 lbs. S. W. P.-2000 lbs. C. W. P. Extra heavy ends and nut with nut threads that are permanently lubricated. The seats are machined and cold rolled.

Pressures from a vacuum to 3000 lbs.: Temperatures from 100° below zero F. to 1000° above zero F.: On Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and any service in which Steel or Wrought Iron Pipe is used.

Orifice

Ideal for flow control of Steam, Oil, Ammonia, Water, Gas or Air. Also for metering and measuring. 600 lbs. S. W. P. or 2000 lbs. C. W. P. The ORIFICE plate is furnished in cold rolled 18-8 stainless steel. ORIFICE plate and gaskets are set in a groove of solid steel to safeguard against blowing of gaskets and resultant trouble. The ORIFICE union has extra heavy ends and nut with the nut threads permanently lubricated.

Sizes ¼" to 3"

ORDER BY TRADE NAME FROM YOUR LOCAL SUPPLY STORE

ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS SINCE 1912

CLAYTON MARK & COMPANY

1900 DEMPSTER STREET • EVANSTON, ILLINOIS

CUT HEAT EXCHANGER REPLACEMENT COSTS WITH

"KARBATE"

BRAND

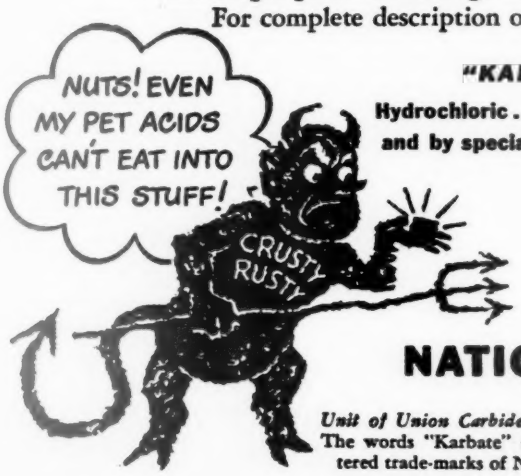
HEAT EXCHANGERS — THEY LAST *Indefinitely*

● "Karbate" Heat Exchangers will help you end the expense and delay of constantly replacing corroded heat exchangers!

"Karbate" Heat Exchangers are chemically inert. They are free from corrosion scale formation. Thus, they will stay on the job indefinitely—saving substantial replacement costs over the years.

"Karbate" Heat Exchangers have other stand-out features: A remarkably high rate of heat transfer • Extreme heat shock resistance • Light weight • Strong, sturdy — able to take rough treatment • Can be made in a variety of sizes and types from the simple plate to the large tube-bundle types.

For complete description of "Karbate" Heat Exchangers, write Dept. PE.



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This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-14, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue; 98-100, inclusive, in the October, 1945, issue; 101-103, inclusive, in the January, 1946, issue; 104-106, inclusive, in the April, 1946 issue; 107-109, inclusive, in the July, 1946, issue; 110-112, inclusive, in the October, 1946, issue.

INDEX TO TABLES

		Index No.	*Page*	*Issue*
Graphic method of selecting roller chain drives		P 425.234.1	221	Dec.
Analysis of the source of oil and gas reservoir energy		P 501.7	215	Dec.
Effect of reservoir temperature on oil recovery		P 501.7	217	Dec.
Effect of crude gravity on performance of gas drive reservoirs	(sheet 1)	P 501.731.	213	Jan.
Effect of crude gravity on performance of gas drive reservoirs	(sheet 2)	P 501.731.	217	Jan.
Effect of crude gravity on performance of gas drive reservoirs	(sheet 3)	P 501.731.	219	Jan.
Chart for estimation of natural gas reserves		P 530.104.	223	Nov.
Corrosiveness of gas-condensate well waters		P 531.	219	Dec.
Methods of computing flow of oil in pipelines	(sheet 2)	P 615.10	215	Jan.
Methods of computing flow of oil in pipelines	(sheet 3)	P 615.10	225	Jan.
Economical alignments of pipe lines	(sheet 1)	P 615.2	235	Nov.
Economical alignments for pipe lines	(sheet 2)	P 615.2	223	Dec.
Methods of computing flow of oil in pipe lines		P 615.10	225	Dec.
Refrigeration and horsepower calculations		P 728.	227	Dec.
Thermodynamic properties of propane	(sheet 1)	P 771.214.736.	225	Nov.
Thermodynamic properties of propane	(sheet 2)	P 771.214.736.	227	Nov.
Thermodynamic properties of propane	(sheet 3)	P 771.214.736.	229	Nov.
Thermodynamic properties of propane	(sheet 4)	P 771.214.736.	231	Nov.
Thermodynamic properties of propane	(sheet 5)	P 771.214.736.	233	Nov.
Evaluation of absorber operating efficiency	(sheet 1)	P 733.	221	Jan.
Evaluation of absorber operating efficiency	(sheet 2)	P 733.	223	Jan.

INDEX TO ADVERTISERS IN TABLES

		Page	*Issue*	*Backing Table No.*
Goetze Gasket & Packing Co., Inc.	(sheet 2)	216	Jan.	P 615.10
Griscom-Russell Co., The	(sheet 2)	224	Jan.	P 773.
Gustin-Bacon Manufacturing Company, The	(sheet 3)	220	Jan.	P 501.731.
Linde Air Products Company, The	(sheet 3)	226	Jan.	P 615.10
Nash Engineering Company	(sheet 1)	222	Jan.	P 773.
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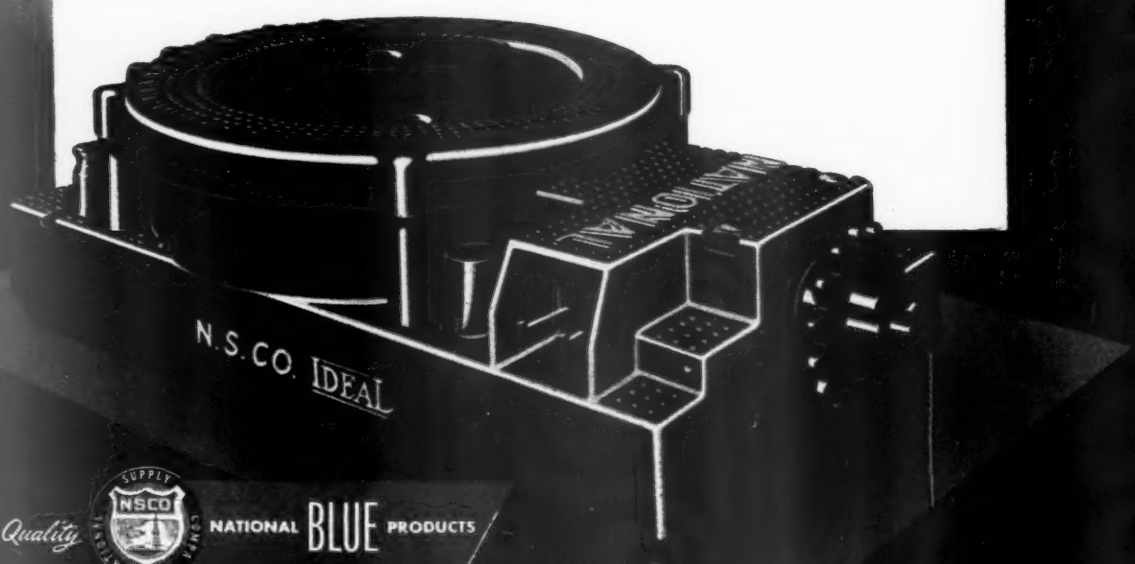

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EFFECT OF CRUDE GRAVITY ON PERFORMANCE OF GAS DRIVE RESERVOIRS

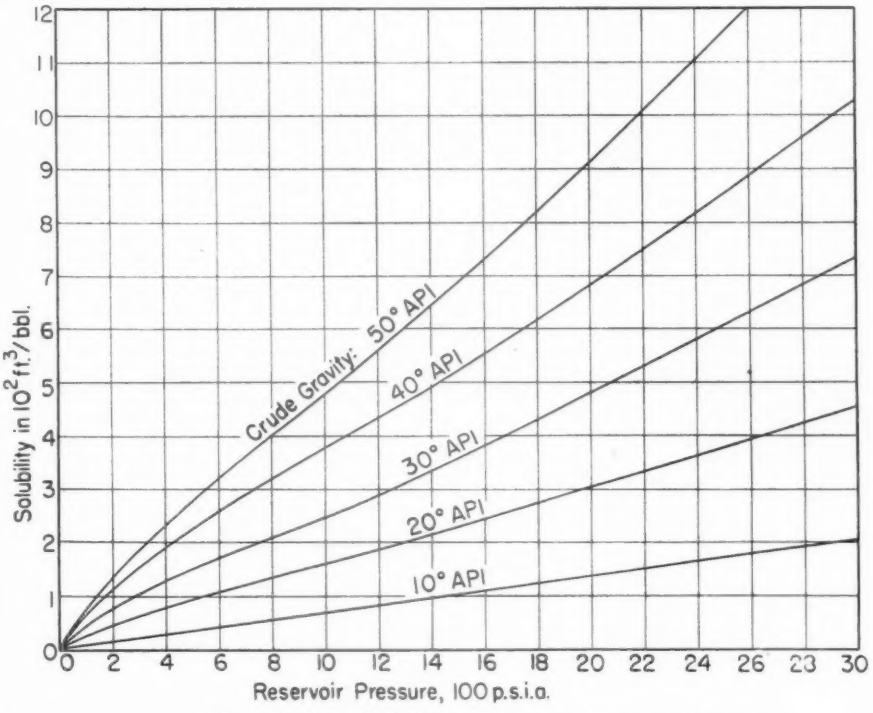

FIG. 1. Gas solubility vs. pressure, at reservoir temperature, assumed for different API gravity crudes.

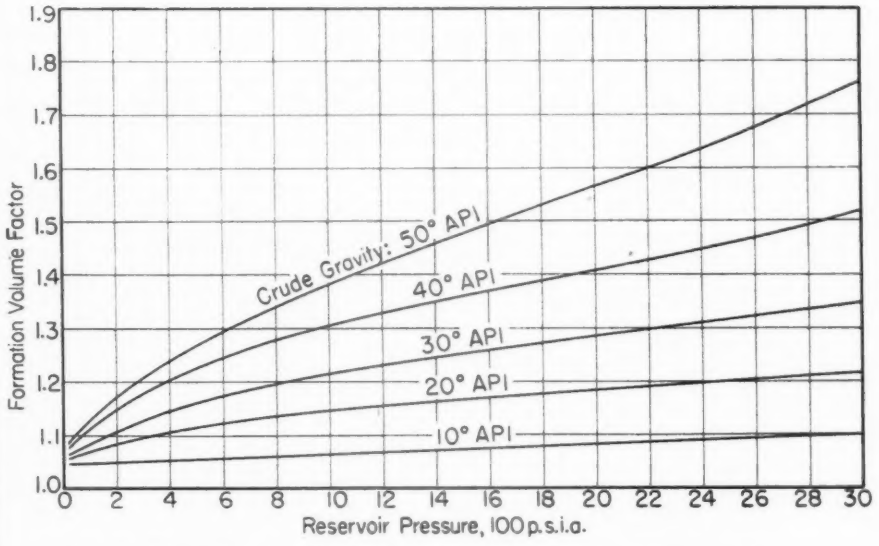

FIG. 2. Formation volume factor for liquid phase vs. pressure at reservoir temperature assumed for different API gravity crudes.

Basic reservoir data: The solubility curves as functions of the reservoir pressure, used in the calculations reported here, are plotted in Fig. 1.

The formation volume factors, as functions of the reservoir pressure, which were used in the calculations are plotted in Fig. 2.

(This series of charts and data is taken from the exclusive article by Morris Muskat and M. O. Taylor, published in The Petroleum Engineer in December, 1946, pages 88-98, inclusive.)

In a recent paper[1] were given the results of calculations on the theoretical behavior of ideal solution gas drive reservoirs, as it may be affected by the various fluid and rock properties. These included the effects of oil viscosity, gas solubility, oil shrinkage, size of gas cap, amount of connate water, and details of the gas to oil permeability ratio curve. In order to bring out most clearly the individual effects of these properties, calculations were made under conditions where the different physical parameters were varied separately, the remaining functions of pressure and oil saturation being kept fixed. With respect to the role played by the shrinkage of the oil, calculations were also made in which the amount of shrinkage was varied in proportion to changes in the gas solubility, for the two are obviously intimately related.

Although these studies have served to indicate the separate effects of the various features controlling the performance of gas drive reservoirs, they do not show directly the behavior to be expected of actual crude oil producing fields. To make predictions of the histories of specific reservoirs, numerical data pertaining to the particular systems of interest would have to be used and the calculations repeated for each case. On the other hand, it is possible to derive the gross features of general gas drive reservoir performance by characterizing the nature of the fluids produced by means of the gravity of the crude oil.

[1]M. Muskat and M. O. Taylor, *AIME Petroleum Technology 8*, 1-16, September, 1945.

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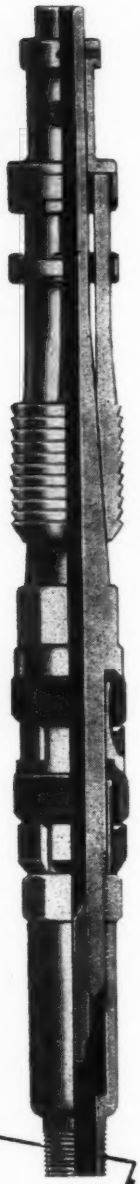

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METHODS OF COMPUTING FLOW OF OIL IN PIPELINES

Considering the relationships of f and R, it is apparent that for a liquid of given viscosity, flowing through a pipe of given diameter, f is a function solely of B, and *for practical ranges of B in that pipe diameter*, $f = c\,B^m$. We are not going to consider 20 bbl. per hr. through a 12-in. pipe, nor pump 1000 bbl. per hr. through a 4-in.

For a given pipe diameter, equation (1) is of the form:

$$h = f\,e\,B^2 \text{ with } e = \frac{15.25}{d^5}$$

Substituting the value of f found in the preceding paragraph:

$h = (c\,B^m)\,(e\,B^2) = a\,B^n$ (with $a = c\,e$ and $n = 2m$).

Taking logarithms of each side of this equation:

$\log h = n \log B + \log a$

Now, let us assume a crude oil of 42 deg. API gravity, and 35 SUS viscosity. We require equations for 4-in., 6-in., and 8-in. pipe for field connections; 10-in. and 12-in. for main lines. Beginning with the 4-in. it will be necessary to take several values of B, covering a range from 75 to 300, and after solving equation (1) for the corresponding values of h, place the results in the logarithmic form shown above. If the reader's flow tables or curves have proved reliable, he can save time by taking these values directly from them, but the solution by logarithms gives a better understanding of the various relationships involved. As in any engineering computation, it will pay to be systematic.

Similar solutions for B = 225, and B = 300 show that:

B = 225	log 225 = 2.35218
B = 300	log 300 = 2.47712
log h = 1.8554	h = 15.33 ft.
log h = 1.40987	h = 25.7 ft.

Referring back to the logarithmic form of the equation $h = a\,B^n$, we write it out and place under each of its terms the values we have just found. If hydraulic data were more exact, it would be proper to solve the ensuing equation by "least squares," but for field pipe-line conditions a simple averaging gives as much precision as the data warrant.

(B)	log h =	n log B +	log a	
(75)	0.35779 =	1.87506 n +	log a	
(150)	0.88221 =	2.17609 n +	log a	
2	1.24000 =	4.05115 n +	2 log a	
average	0.62000 =	2.02557 n +	log a	(1)
(225)	1.18554 =	2.35217 n +	log a	
(300)	1.40987 =	2.47712 n +	log a	
2	2.59541 =	4.82930 n +	2 log a	
average	1.29770 =	2.41465 n +	log a	(2
	−0.62000 =	2.02557 n +	log a	(1
	0.67770 =	0.38908 n		

n = 1.742

Substituting this value of n in the averaged equations:

$\log a = -(2.90813)$

$a = \frac{1}{809}$

35 SUS = 0.026 stokes kin. vis. d = 4.026 in.

$R = 22.14\,\frac{B}{dz}$ $\qquad h = f\,\frac{15.25\,B^2}{d^5}$

log 22.14		1.34518	log 15.25		1.18331
log 0.026	8.41497−10		5 log 4.026		−3.02435
log 4.026	0.60487		log 15.25/d^5		8.15896 − 10
	9.01984−10	−9.01984−10			
log 22.14/dz		2.32534			

B = 75

log 75	1.87506	2 log 75		3.75012
log 22.14/dz	2.32534	log 15.25/d^5		8.15896 − 10
log R	4.20040			
R	15,850			
f	0.0281	log 0.0281		8.44871 − 10
		log h		0.35779
		h		2.28′

B = 150

log 150	2.17609	2 log 150		4.35218
log 22.14/dz	2.32534	log 15.25/d^5		8.15896 − 10
log R	4.50143			
R	31,730			
f	0.0235	log 0.0235		8.37107 − 10
		log h		0.88221
		h		7.62 ft.

Then, for a crude of 35 SUS viscosity, through 4-in. pipe:

$$h = \frac{B^{1.74}}{809}$$

and $B = (809\,h)^{0.57} = 46.73\,h^{0.57}$

For the 6-in. line we might take values of h at 200, 300, 400, 500, 600, and 700 bbl. per hr.; average their respective logarithms in two sets of three each, and solve the resulting equations (1) and (2) by the same process as above. For the 8-in. line, we should take a range of from 400 to 1000 bbl. per hr.; for the 10-in., a range of from 1000 to 2000 bbl. per hr.; for the 12-in., a range of from 2800 bbl. per hr. Tabulating the results:

"X" crude
35 SUS viscosity 42 deg. API

4 in.	$h = \frac{B^{1.74}}{809}$	$B = 46.73\,h^{0.57}$
6 in.	$h = \frac{B^{1.78}}{7190}$	$B = 145\,h^{0.56}$
8 in.	$h = \frac{B^{1.81}}{32{,}050}$	$B = 308.6\,h^{0.55}$
10 in.	$h = \frac{B^{1.84}}{126{,}750}$	$B = 591.3\,h^{0.54}$
12 in.	$h = \frac{B^{1.85}}{325{,}100}$	$B = 931.5\,h^{0.53}$

To express the hydraulic gradient in lbs. per sq. in. per mile, we multiply h by 5.28 (as h is in units of 1000 ft.), and, noting that 42-deg. API is equivalent to a specific gravity of 0.8155 and that a water column of 2.31 ft. produces a pressure of 1 lb. per sq. in., we divide h by 2.31/0.8155, or 2.83, which is the height, in ft., of the column of 42-deg. API crude giving a pressure of 1 lb. per sq. in. For example:

$$h_{4''} = \frac{B^{1.74}}{809.3} \qquad p = \frac{5.28\,h}{2.83}$$

$$p_{4''} = \frac{5.28\,B^{1.74}}{(2.83)\,(809.3)} = \frac{B^{1.74}}{424}$$

and $B = 32.65\,p_{4''}^{0.57}$

We won't take the space to put all "head in feet" equations into the "head in lb. per sq. in." form, but for your notebook you will find it convenient to do so. For each field whose oil you are running, you should have a record of the variations of viscosity and gravity with varying temperatures, especially the average "summer" and "winter" temperatures, and these data, with the appropriate equations such as those derived above, can be tabulated handily on a separate page of your field-book.

These data are taken from the article entitled, "Simplified pipe line computations," by Peyton Bryan, in the December, 1946, issue of *The Petroleum Engineer*, pages 152 to 156, inclusive.

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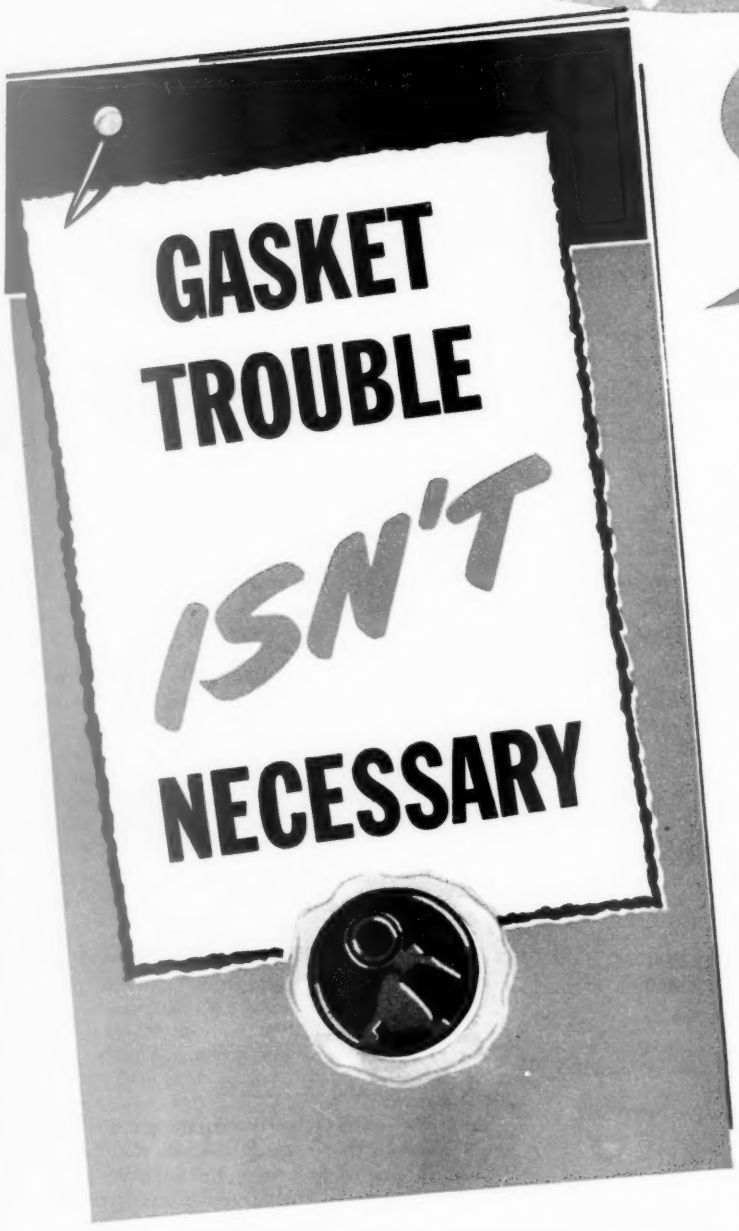

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EFFECT OF CRUDE GRAVITY ON PERFORMANCE OF GAS DRIVE RESERVOIRS

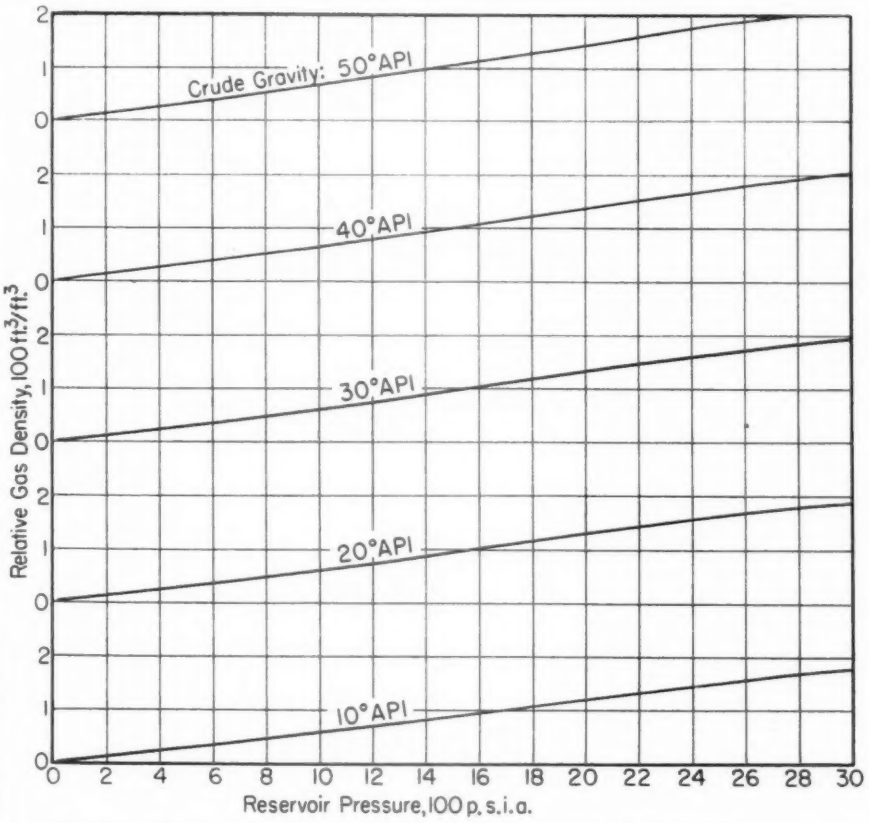

FIG. 3. Relative gas density vs. pressure, at reservoir temperature, assumed for gas liberated from various API gravity crudes.

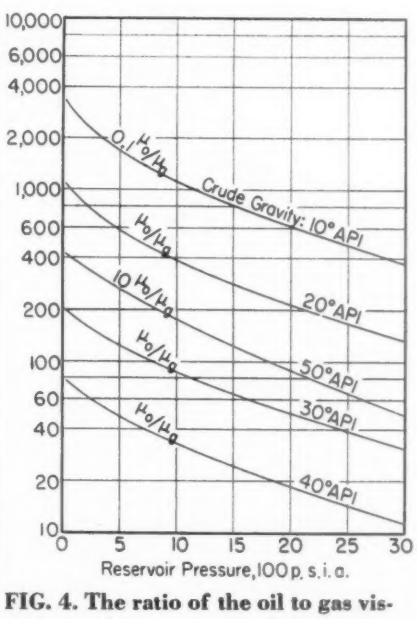

FIG. 4. The ratio of the oil to gas viscosity, μ_o/μ_g, at reservoir temperature, assumed for different API gravity crudes.

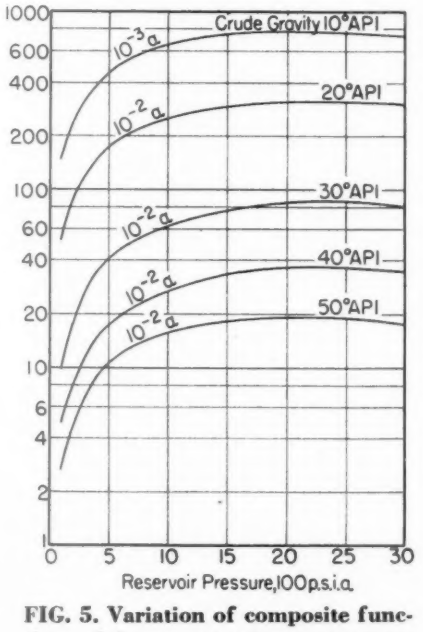

FIG. 5. Variation of composite function $\alpha(\rho)$, at reservoir temperature, with pressure for different API gravity crudes.

(This series of charts and data is taken from the exclusive article by Morris Muskat and M. O. Taylor, published in The Petroleum Engineer in December, 1946, pages 88-98, inclusive.)

Early work of Katz[2], and a recent study by Beal[3] have shown that the P-V-T properties of crude oil and natural gas systems can be correlated with the crude oil gravity.

The relative gas densities used in the calculations are plotted in Fig. 3. It was assumed that this gravity remained substantially the same throughout the pressure depletion range*. Using these gravies for each crude oil, the relative density as a function of pressure was then calculated by the Standing and Katz[4] charts to determine the deviation factors of the gas as corrections to the Boyle's law perfect gas density.

The variation with pressure of the fluid reservoir viscosity ratio, assumed for the calculations, is plotted in Fig. 4. The gas viscosity, as a function of pressure, was determined from the correlation charts of Bicher and Katz[5] as converted to a gas gravity scale by Beal (Figs. 5 and 6).

The crude oil viscosities at atmospheric pressure and 190° F. were obtained by reference to Fig. 8 of Beal. The viscosity of the gas saturated oils at various reservoir pressures was then determined by reference to Fig. 9 of Beal. The resulting ratios so found are plotted in Fig. 4.

*This assumption will, of course, seldom be strictly valid. It will be least satisfactory at low pressures and for the higher gravity crudes; however, the average values given by the Katz chart should not cause serious errors in the results, for the integral of the basic equation (2) is not sensitive to the exact form of the gas density function.

[2]D. L. Katz, *API Drilling and Production Practice*, 137-47 (1942).

[3]C. Beal, *AIME Petroleum Technology 9*, 1-22, March, 1946.

[4]M. B. Standing and D. L. Katz, *AIME Petroleum Development and Technology 146*, 140-9 (1942).

[5]L. B. Bicher, Jr. and D. L. Katz, *AIME Petroleum Development and Technology 155*, 246-52 (1944).

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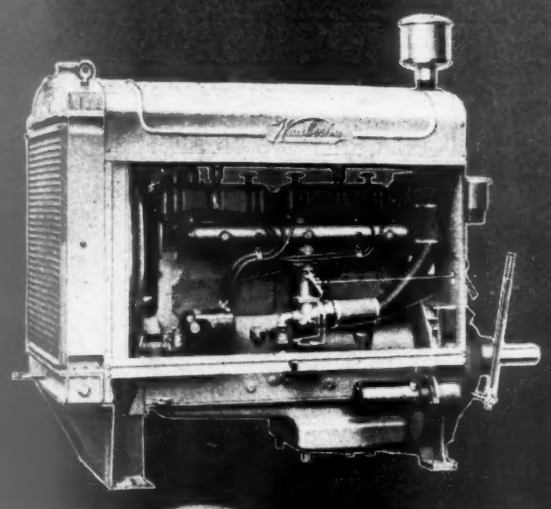

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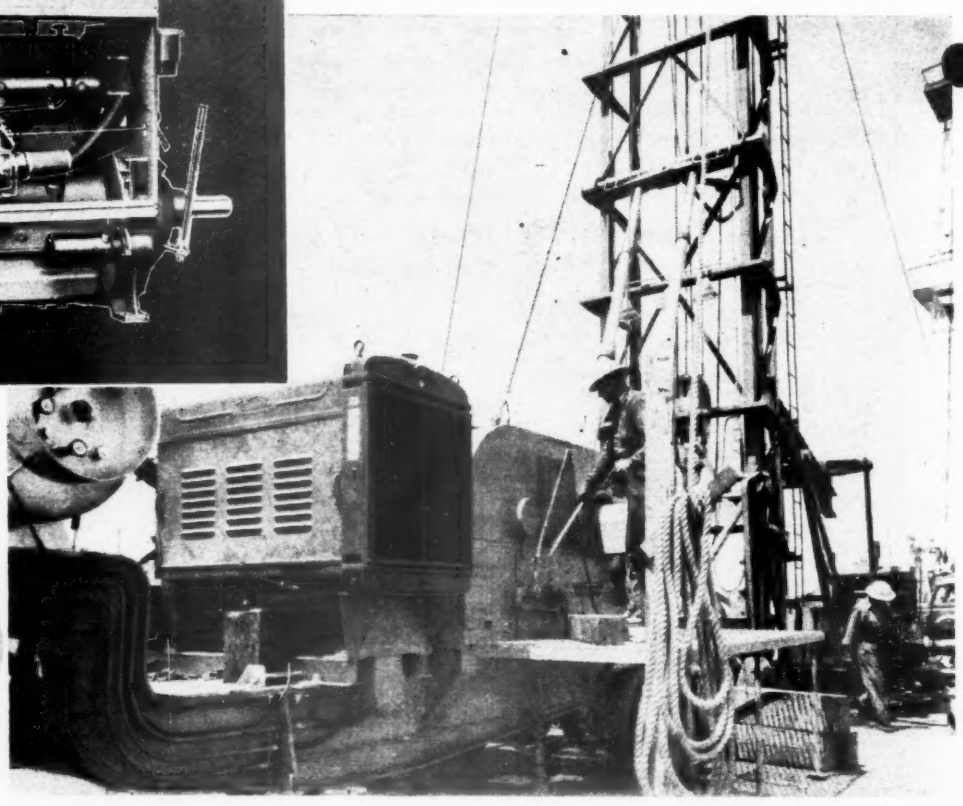

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EFFECT OF CRUDE GRAVITY ON PERFORMANCE OF GAS DRIVE RESERVOIRS

(This series of charts and data is taken from the exclusive article by Morris Muskat and M. O. Taylor, published in The Petroleum Engineer in December, 1946, pages 88-98, inclusive.)

To apply these basic data (see sheets 1 and 2) to the calculation of reservoir performance curves certain derived functions must first be evaluated. These may be defined by the equations:

$$\alpha(p) = \frac{\gamma\beta\mu_o}{\mu g};$$

$$\lambda(p) = \frac{1}{\gamma\beta}\frac{dS}{dp};$$

$$\xi(p) = \frac{1}{\gamma}\frac{d\gamma}{dp};$$

$$\eta(p) = \frac{\mu_o}{\beta\mu_g}\frac{d\beta}{dp};$$

. . . . . (1)

γ = the relative gas density as plotted in Fig. 3,

β = the formation volume factor of the oil as plotted in Fig. 2,

μ_o/μ_g = the ratio of oil to gas viscosity shown in Fig. 4, and

S = the gas solubility, such as plotted in Fig. 1.

From the curves of Figs. 2, 3, and 4 values of α were calculated, and the results so found for the different crude oil gravities are plotted in Fig. 5 (sheet 2). The value of $\lambda(p)$, as obtained by taking the derivatives of the curves of Fig. 1, and combined with the data of Figs. 2 and 3, are plotted in Fig. 6. The values of $\xi(p)$, as derived from the curves of Fig. 3, were found to be almost identical for the different crude gravities, within the inherent uncertainties in the basic data. Accordingly, a single average curve, as plotted in Fig. 7, was used for all the crude gravities. By combining the curves for α with the data plotted in Figs. 2 and 3, values for the function of $\eta(p)$ were determined. These are plotted for the different crude gravities in Fig. 8.

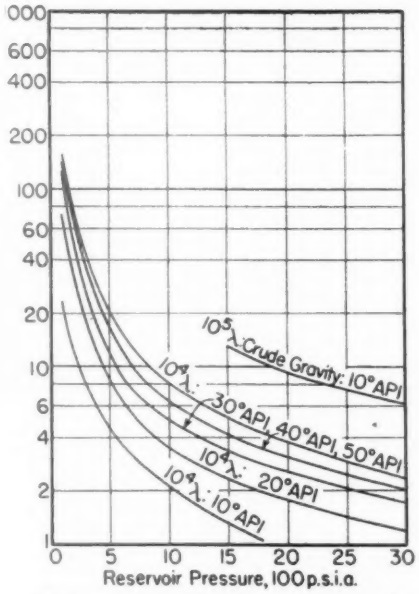

FIG. 6. Variation of the function $\lambda(p)$, at reservoir temperature, with pressure for different API gravity crudes.

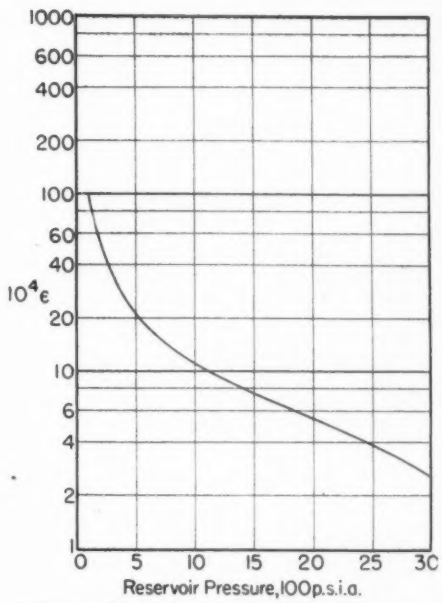

FIG. 7. Variation of the function $\xi(p)$, at reservoir temperature, with pressure for different API gravity crudes.

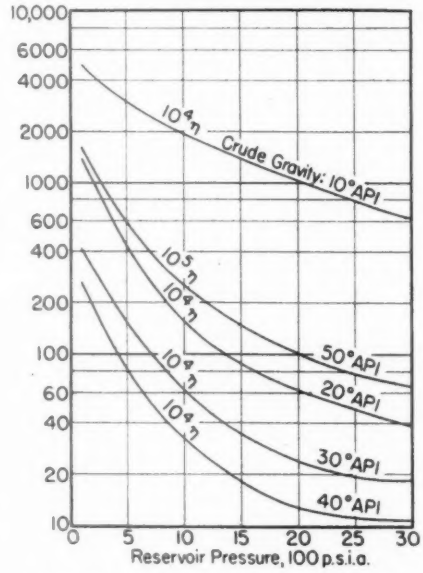

FIG. 8. Variation of the function $\eta(p)$, at reservoir temperature, with pressure.

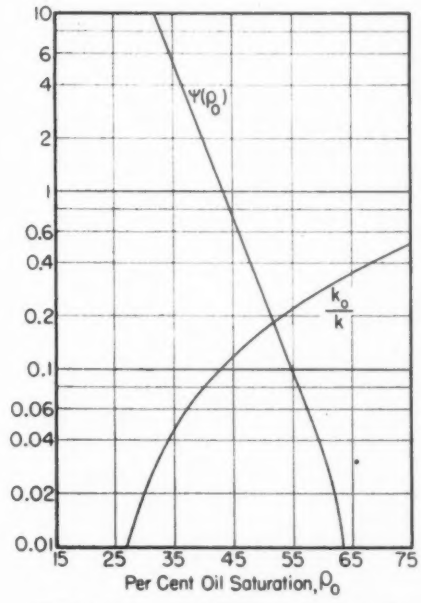

FIG. 9. Permeability ratio function and relative permeability to oil assumed for calculating gas drive histories for different API gravity crudes.

The permeability ratio ψ (ρ_o) was taken in all cases to be that given in Fig. 9, the curve being considered as approaching zero at an oil saturation of 65 per cent, which implies an equilibrium free gas saturation of 10 per cent. The relative permeability to oil, to which reference will be made later, is also plotted in Fig. 9.

PUMPING 40% LONGER*

DEEP IN THE SANDS OF TEXAS

★ FORT WORTH

EXPAN-SEAL

FLEXING PLUNGER For Oil Well Pumps

CASE HISTORY 341*

A 2750' Well Near Fort Worth, Texas – This well is difficult to pump, as it pumps off frequently and the oil contains a considerable amount of sand.

Before the EXPAN-SEAL Plunger was tried, plungers previously used had a service life varying from 8 to 21 days before recupping was necessary. An EXPAN-SEAL was installed on July 18 and removed for recupping August 27 after 40 days in the well. It was in actual operation 29 days, thus giving a service record 40%, or more, longer than the other types of plungers used.

NO GAS LOCKING–LESS RECUPPING–MORE WEAR (wear varying from 2 to 6 times longer depending on pumping conditions).

Check these outstanding advantages of the G-B EXPAN-SEAL Plunger for insert pumps having either traveling plunger or traveling tube, or for common working barrels.

Check the new principle of operation! EXPAN-SEAL cups bear on the wall *only on the lifting stroke.* They contract on the return strokes to save wear and allow gas and sand to escape. Even when considerably worn EXPAN-SEAL Cups expand to the tube wall, –giving full efficiency for the life of the cups.

Now Available At Your Supply Store

Manufactured Under Hunter Patents Exclusively By . . .

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KANSAS CITY 7, MO.

ESTABLISHED 1898 NEW YORK CHICAGO PHILADELPHIA HOUSTON SAN FRANCISCO TULSA FORT WORTH

EVALUATION OF ABSORBER OPERATING EFFICIENCY

The absorption factor "A" of this chart can best be defined as:

The ratio of the amount of a given component absorbed on a tray to the amount of that same component absorbed on the immediate tray above.

By mathematical analysis, Souders and Brown have shown that for the ideal column:

$$A = \frac{y_{n+1} - y_{11}}{y_n - y_{n-1}} = \frac{L}{V} \times \frac{1}{K}$$

Where:

L = total moles of liquid flowing between trays.

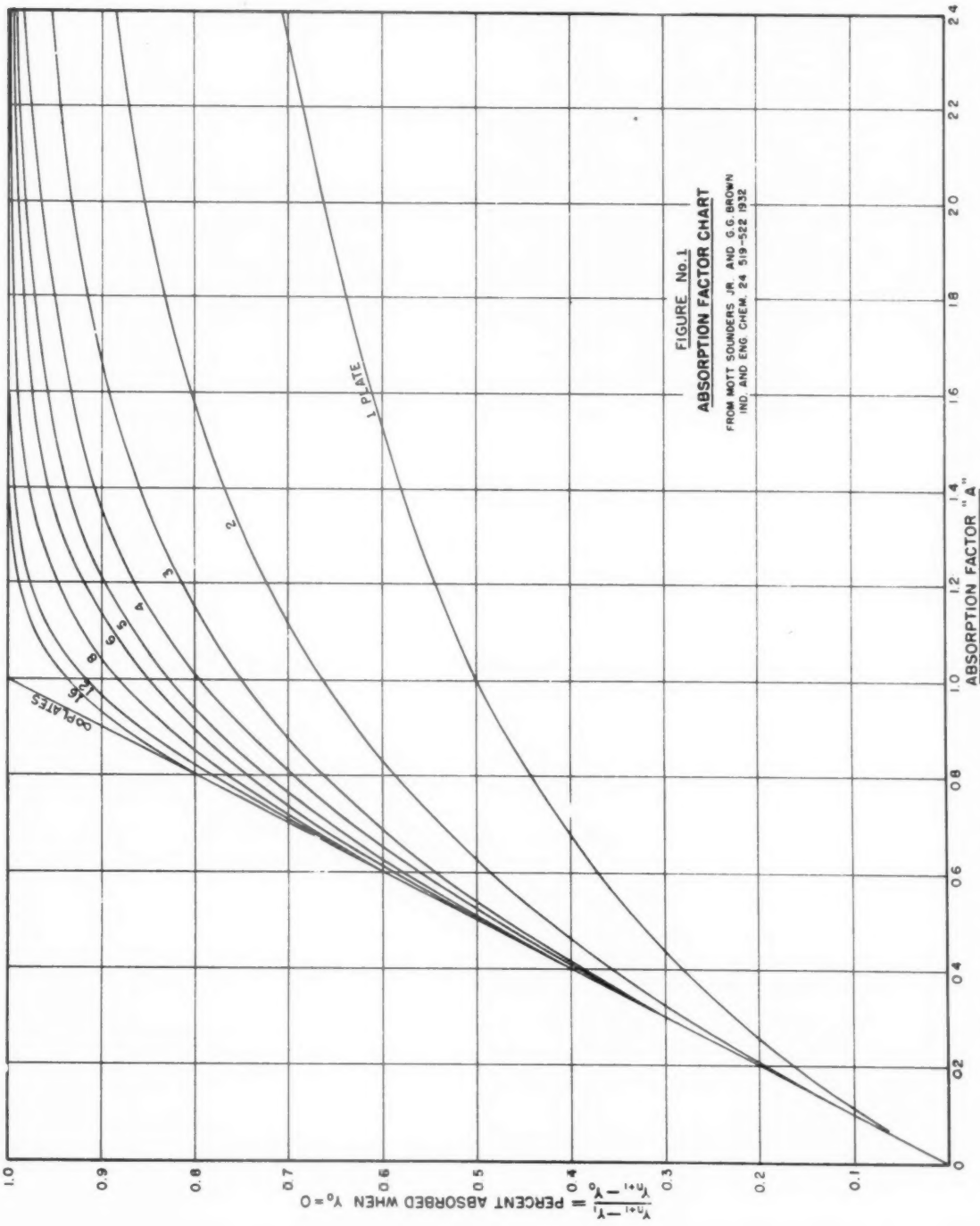
V = total moles of gas flowing between trays.

x = mole fraction of a component in the liquid

y = mole fraction of a component in the gas.

$K = \frac{y}{x}$ = vapor-liquid equilibrium constant (a function of temperature and total pressure for each component), and,

n = number of plate, beginning at the top plate of the absorber (when used as a subscript indicates plate of origin from which the liquid overflows or the vapor rises).



—Taken from the article by E. G. Ragatz and J. A. Richardson in the December, 1946, issue of the Petroleum Engineer, pages 53-58, inclusive.

This Simple Compressor Meets the Complex Needs of a Changing Petroleum Industry

It's the Nash!

Here is a compressor presenting advantages found in no other device. Nash Compressors have only one moving part, rotating without metallic contact with the pump casing. No internal lubrication is required. Yet they produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure.

There are no valves, gears, pistons, sliding vanes, or other complicated wearing parts in a Nash. Compression is secured by an entirely different principle of operation. Because of this, gas pumping problems difficult with ordinary pumps are often easily handled by the Nash. For example, Nash Pumps are standard equipment in the Synthetic Rubber Industry, where they have met the needs of new and difficult processes.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. They maintain original performance over long periods. Service is assured by a nationwide net-work of Engineering Service offices. Instructive bulletin shows how they operate. Write for it.

One moving part.

No internal wearing parts.

No valves, pistons, or sliding vanes.

No internal lubrication.

Low maintenance.

Slugs of liquid entering pump do no harm.

Non-pulsating pressure.

Saves floor space.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

272 WILSON, SO. NORWALK, CONN.

EVALUATION OF ABSORBER OPERATING EFFICIENCY

The first step of our operating data analysis required the selection of a sound basis for calculating the mean absorbtion factor. Fortunately, this particular task has already been adequately handled by Edmister[3] in his recent analysis of Horton and Franklin's[4] proposed absorption calculation method. Edmister's mean absorption factor is based on the "A" factors existing at the top and bottom of the column, and may be expressed as:

$$A_e = \sqrt{A_B(A_T+1)} - 0.25 - 0.5$$

Where:

A_e = effective or mean absorption factor,

A_B = absorption factor at bottom tray conditions,

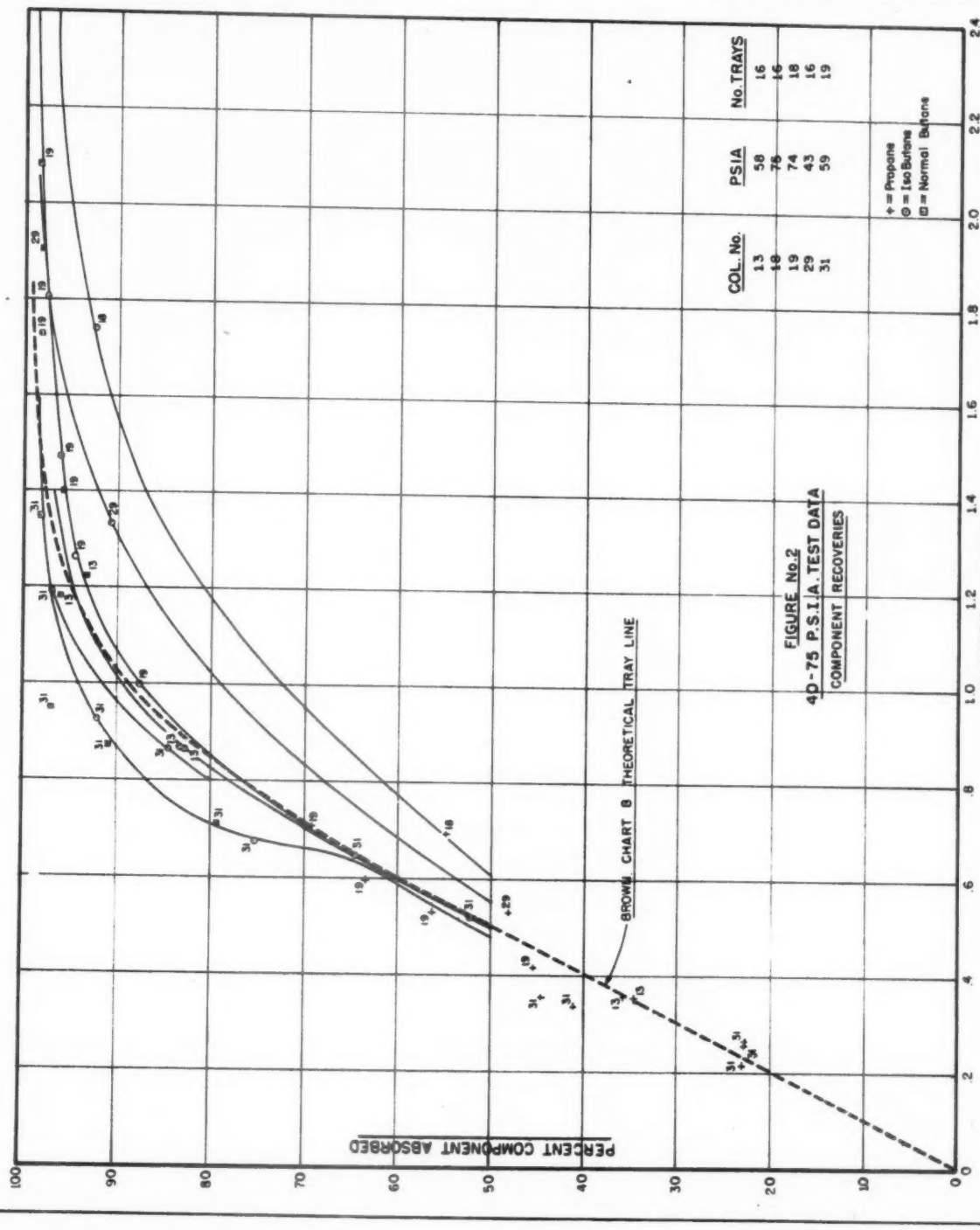
A_T = absorption factor at top tray conditions, and,

$A_n = \frac{L_n}{V_n}\frac{1}{K_n}$ = absorption factor at tray "n".

Although Edmister's original derivation assumed that K's based on the top tray temperature would be used for calculating the top plate absorption factor, we have used "K's" based on the temperature of the fat oil leaving the bottom of the column for calculating both the top and bottom "A" factors.

[3]Edmister, W. C., *Ind. Eng. Chem.*, 35, 837 (1934).

[4]Horton, George, and Franklin W. B., *Ind. Eng. Chem.*, 32, 1384 (1940).



—Taken from the article by E. G. Ragatz and J. A. Richardson in the December, 1946, issue of the Petroleum Engineer, pages 53-58, inclusive.

Check THE FEATURES YOU WANT IN A HEAT EXCHANGER...

You will find them in the

G-R TWIN G-FIN SECTION

Here is a cooler, heater, condenser and heat exchanger whose many advantages have been tested . . . and *proven* . . . in installations totaling more than 40,000 units and by 14 years of performance records.

- **SIMPLICITY** . . . it is the simplest form of heat exchanger; namely, a pipe within a pipe. The inner pipe is the G-FIN element, the outer pipe serves as the shell, and the complete unit is in the form of a patented and exclusive hairpin design.
- **STURDINESS** . . . units may be furnished for pressures up to 5000 psi. in the elements and up to 2000 psi. in the shells.
- **EFFECTIVENESS** . . . the large exterior heat transfer surface of the G-FIN elements enables one element to do the work of 6 to 8 bare tubes of the same size and length.
- **SERVICE ADAPTABILITY** . . . may be used for a wider variety of services than any other type of heat transfer apparatus . . . and may be readily converted from one service to another.
- **INTERCHANGEABILITY** . . . units are standard and interchangeable, permitting easy changes in installations to meet changes in capacity, temperature range, or other service conditions.
- **DEPENDABILITY** . . . thoroughly proven by long service in many thousands of installations on a wide range of applications.
- **LOW MAINTENANCE EXPENSE** . . . assured by rugged construction, absence of stuffing boxes and rolled tube joints, free expansion and contraction, ready accessibility of all parts, and ease of inspection and cleaning.

Write for Bulletin 1614 describing the G-R Twin G-Fin Section in detail.

THE GRISCOM-RUSSELL CO., 285 Madison Ave., New York 17, N. Y.

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GR-129

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

METHODS OF COMPUTING FLOW OF OIL IN PIPELINES

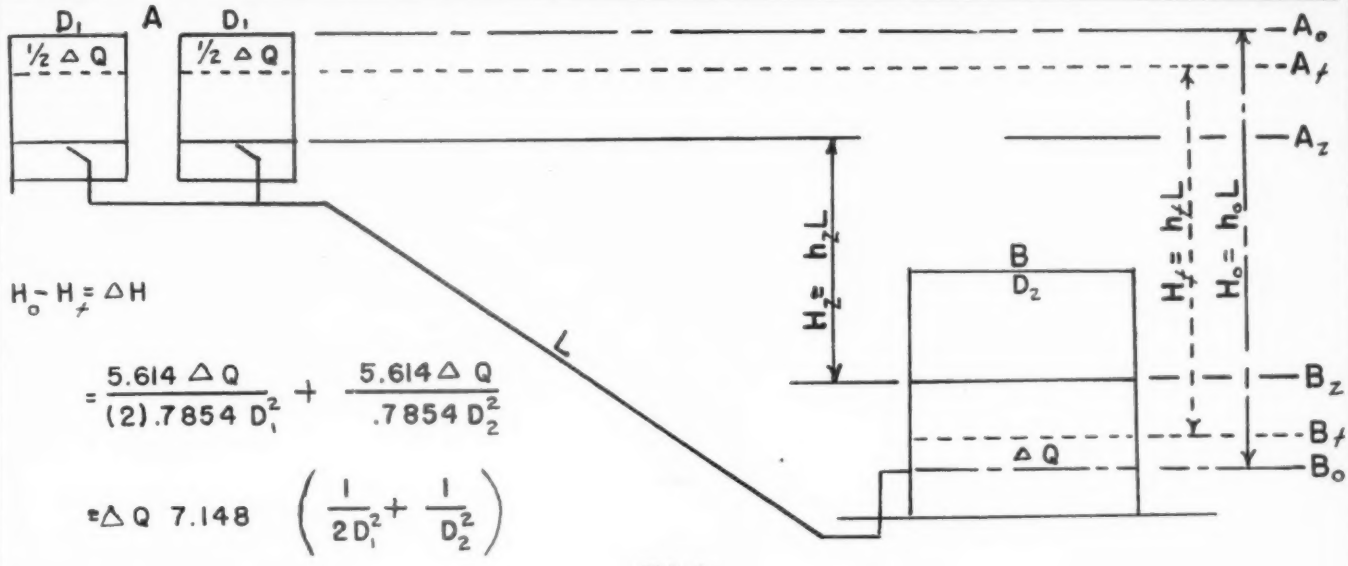


FIG. 1.

Application of equations to gravity lines and gravity systems. In preceding discussions we have derived the general equations for pipe-line flow, and, finding the presence of the friction factor f an embarrassment, have seen that for a specific grade of crude, flowing through a given pipe diameter *within the practical range of flow rates for that diameter*, f is a function solely of the flow rate B and can be incorporated into the other constants, giving an equation of the form $h = a B^n$. This permits a direct solution for either hydraulic gradient h or flow rate B, by log-log slide-rule or two logarithmic operations, and provides an easier path to the solution of more complex problems.

Consider Fig. 1, which represents a battery of two lease tanks from which oil is to be gathered into the working, or storage, tank, (B). When the lease-tanks are "turned on," the oil level within theme is at elevation A_o, and the oil level in the storage tank is at elevation B_o, giving an initial "head" of H_o, When the battery is "turned off" at elevation A_z, there will have flowed through the line a quantity of oil, Q barrels, which will have raised the storage tank oil level to B_z, reducing the head to H_z. Practically, the problem is to determine how much time is required to "run" the two tanks of oil.

Assuming the two lease tanks to be of the same diameter, D ft., a flow of Δ Q in the interval of time Δ t hours will lower their oil level by a height of ½ Δ Q (5.614) divided by the cross-sectional area of one of the tanks, while the oil level in the storage tank, whose diameter is D_2 ft., will rise a distance of Δ Q (5.614) divided by the cross-sectional area of that tank. Thus, the decrease in head Δ H is equal to the arithmetical sum of these two changes, or:

$$\Delta H = \Delta Q \frac{5.614}{0.7854}\left(\frac{1}{D_2^2}+\frac{1}{2D_1^2}\right)$$

$$= \Delta Q\,(7.148)\left(\frac{1}{2D_1^2}+\frac{1}{D_2^2}\right)$$

Let $(7.148)\left(\frac{1}{2D_1^2}+\frac{1}{D_2^2}\right) = c$

Then $\frac{dQ}{dH} = \frac{1}{c}$

By definition, B is the rate of change of Q with respect to time, or:

$$B = \frac{dQ}{dt} = a\,h^n = a\left(\frac{H}{L}\right)^n = \frac{a\,H^n}{L^n}$$

Let $\frac{a}{L^n} = b$

Then $\frac{dt}{dQ} = \frac{1}{b\,H^n}$

$$\frac{dt}{dH} = \frac{dt}{dQ}\frac{dQ}{dH} = \frac{1}{b\,H^n}\frac{1}{c} = \frac{1}{b\,c}H^{-n}$$

$$t = \frac{1}{b\,c}\int_{H_z}^{H_o} H^{-n}\,dH$$

$$= \frac{1}{b\,c}\frac{1}{(-n+1)}\left(H_o^{1-n} - H_z^{1-n}\right)$$

For example, if D_1 is 21 ft.; D_2 is 40 ft.; the initial head H_o is 24 ft.; 14 ft. of oil is to run from each tank; then:

$$H_z = H_o - \left(14 + \frac{2(14\times 0.7854\times 21^2)}{0.7854\times 40^2}\right)$$

$$= 2.3 \text{ ft.}$$

As we previously worked out equations for a crude of 42-deg. API and 35 SUS viscosity, we will suppose that to be the grade in the tanks. The pipe line is 4000 ft. of 4-in.

$$c = (7.148)\left(\frac{1}{2\times 441}+\frac{1}{1600}\right) = \frac{1}{79.54}$$

For 4-in., $B = 46.73\left(\frac{H}{L}\right)^{0.57}$

and $\frac{1}{b} = \frac{4^{0.57}}{46.73} = \frac{2.2}{46.73}$

$$t = \frac{2.2}{46.73}(79.54)\frac{1}{0.43}$$

$$(24^{0.43} - 2.3^{0.43}) = 19.7 \text{ hr.}$$

Trying 6-in. for the line:

$$B = 145\left(\frac{H}{L}\right)^{0.56} \text{ and } \frac{1}{b} = \frac{4^{0.56}}{145}$$

$$= \frac{2.17}{145}$$

$$t = \frac{2.17}{145}(79.54)\frac{1}{0.44}$$

$$(24^{0.44} - 2.3^{0.44}) = 7.1 \text{ hr.}$$

The situation pictured in Fig. 1 would rarely occur in practice, as a pump is usually provided to take suction on the incoming gravity lines and discharge into the storage tank. In this case, ignoring any increase in rate of flow due to suction effect of the pump:

$$\Delta H = \Delta Q\frac{5.614}{0.7854}\frac{1}{2D_1^2} = \frac{7.148}{2D_1^2}$$

$$\text{and } c = \frac{7.148}{2D_1^2}$$

$H_z = H_o$ — (number of feet of oil to be run from each tank).

With a suction pump, then, the time required to run 14 ft. of oil from each of the tanks would be (for 4 in.):

$$t = \frac{2.2}{46.73}(123.4)\frac{1}{0.43}$$

$$(24^{0.43} - 10^{0.43}) = 16.6 \text{ hr.}$$

If 6-in. pipe is used:

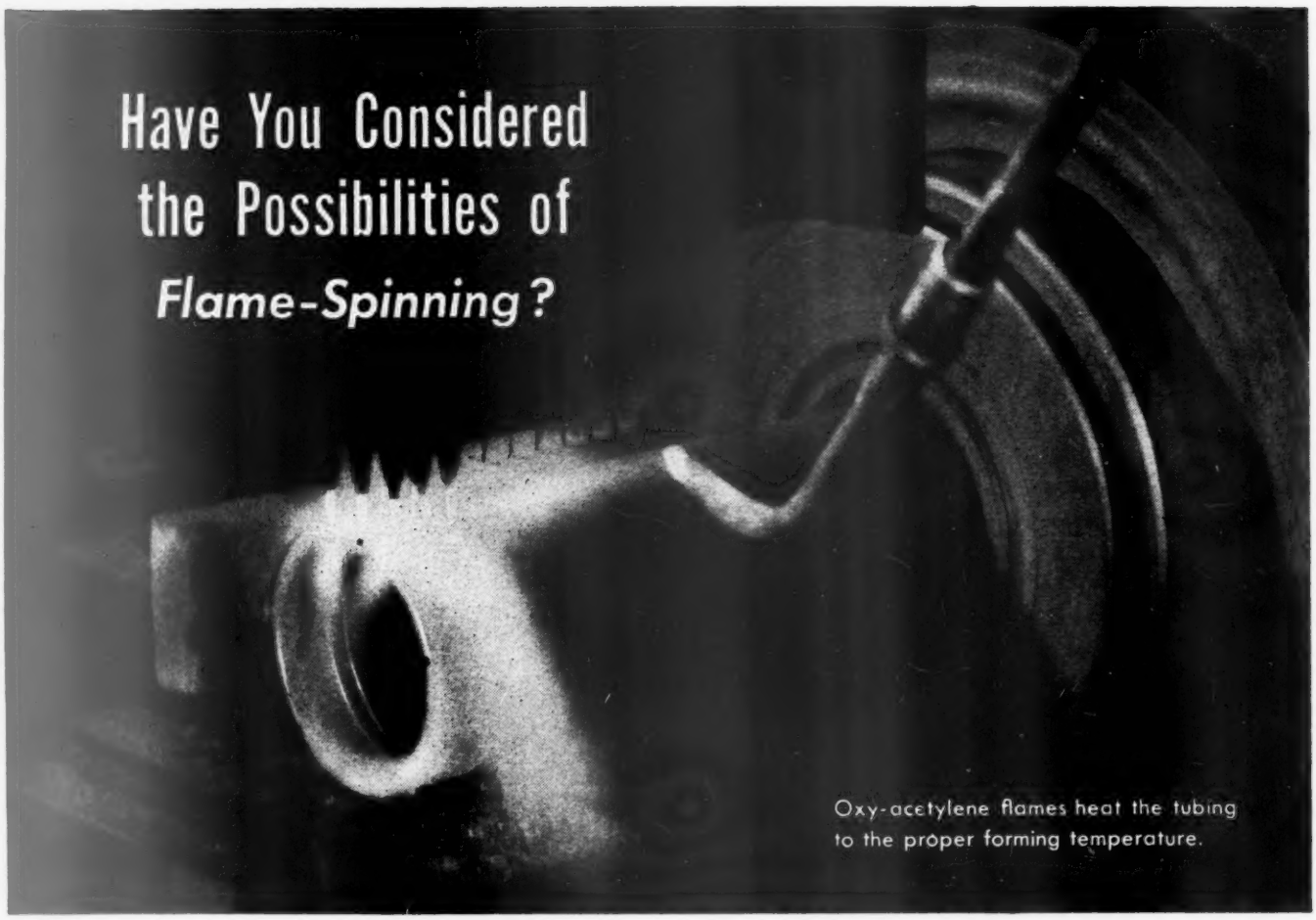
$$t = \frac{2.17}{145}(123.4)\frac{1}{0.44}$$

$$(24^{0.44} - 10^{0.44}) = 5.4 \text{ hr.}$$

Obviously, with low gradients and comparatively short lines, it is impossible to arrive at even a moderately accurate schedule of field runs unless the difference in "tank-heads" is considered.

These data are taken from the article entitled, "Simplified pipe line computations," by Peyton Bryan, in the December, 1946, issue of *The Petroleum Engineer*, pages 152 to 156, inclusive.

Have You Considered the Possibilities of *Flame-Spinning?*



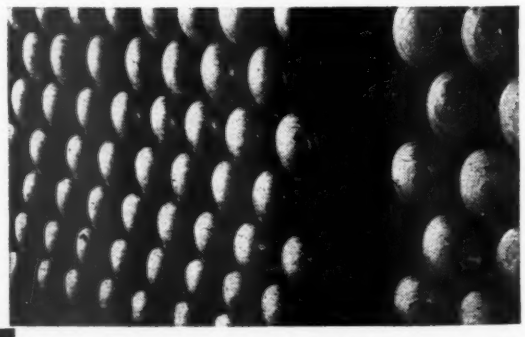
Oxy-acetylene flames heat the tubing to the proper forming temperature.

IT is a fast, inexpensive way to form tubular parts. Flame-spinning will partially close the ends of tubing . . . or make complete closures . . . or reduce diameters at any point. There is no limit to the diameter of tubing that may be flame-spun, provided the ratio of tube diameter to wall thickness does not exceed 50 to 1.

In the pictures, tubing 3 inches in diameter, made from 12-gage sheet, is being end-formed for use in chemical converters. It takes only 45 seconds to close each tube completely.

Ask a Linde representative to show you how you can use the flame-spinning process . . . or write for a copy of the folder, "Flame-Spinning Process," Form 5915.

The flames are withdrawn to allow the forming tool to shape the tube end.



The completely closed tubes are ready for installation in chemical converters.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

Detroit Diesel appoints

The appointment of John C. Campbell as manager of industrial engine sales and of James W. Brown as advertising manager was announced recently by V. C. Genn, general sales manager for the Detroit Diesel Engine Division of General Motors. The appointments were made by Genn at a sales conference held recently in Detroit where plans were laid for activities during 1947.

Campbell, who will now direct industrial sales of the GM Series 71 diesel engine through Detroit Diesel's distributors and dealers, brings to his new job a wide experience in many phases of the business. After his graduation from the University of Detroit with an engineering degree, he spent several years with the Wright Austin Company and with the Frigidaire Division of General Motors. He joined Detroit Diesel in 1942 as a member of the sales department studying the wide uses of the GM Series 71 engine in industrial applications. Since 1945, Campbell has been in charge of advertising and sales promotion activities for the company.

J. W. Brown

J. C. Campbell

Brown, who now takes over as advertising manager, has been directly connected with advertising and publication work since his graduation from Yale in 1927. He spent several years on the advertising staffs of leading publications in Cleveland, Memphis, and Dallas, and for the past year has held the position of product news manager for Detroit Diesel. Brown, who is well known as the author of "What Do GM Diesels Do?", will continue to be in charge of product news for the company.

Heads A.C.S. section

Robert Matteson, supervisor in charge of the analytical division of the Richmond Laboratories of the California Research Corporation, research and development affiliate of the Standard Oil Company of California, has been elected chairman of the California Section of the American Chemical Society for 1947. He succeeds Dr. Louis B. Howard of the Bureau of Agricultural and Industrial Chemistry of the United States Department of Agriculture.

Other new officers of the section are: G. K. Rollefson of the University of California chemistry department, vice chairman; George M. Cook of the California Research Corporation, secretary; Fred D. Tuemmler of the Shell Development Company, treasurer.

Lane-Wells promotions

Morton T. Higgs, Gulf Coast division manager of Lane-Wells Company for the last eight years, has been appointed to the newly created position of manager of field operations and will make his headquarters in Los Angeles, according to Rodney S. Durkee, president. The field activities of the three Lane-Wells divisions and 40 field branches in principal oil areas will be closely coordinated under Higgs to render maximum service, it was announced.

Prior to joining Lane-Wells, Higgs was division manager for eight years of Sperry Sun Well Surveying Company in Texas, Oklahoma, and Kansas. His experience as a geologist includes work with large companies in Texas, Oklahoma, Kansas, Panama, Ecuador, Santo Domingo, and West Indies.

John J. Neale, formerly Gulf Coast division sales manager, has been advanced to the post of Gulf Coast division manager. In ten years with Lane-Wells, he has served as loader, rigman, gun perforator operator, subdistrict superintendent, division sales engineer, district superintendent and division sales manager. He previously had six years' experience with The Texas Pipe Line Company.

C. F. Ludwig, formerly assistant division operating superintendent, succeeds Neale as division sales manager.

H. W. (Pat) Hillebrandt, formerly district operating superintendent at Shreveport, succeeds Ludwig.

K. K. (Shorty) Gage, formerly assistant district operating superintendent at Shreveport, succeeds Hillebrandt.

H. W. Greene, formerly sub-district superintendent at Lake Charles, succeeds Gage.

Dan H. McLendon has been appointed sub-district superintendent at Lake Charles. O. J. Guseman has been made assistant district superintendent at Houston.

C. R. Searcy has returned to the engineering department in Houston and Tom W. Lindsey is the new sub-district superintendent at Victoria.

with CLEVELANDS

...You get the trenching jobs done faster and at less cost... because of their...

SUPERIOR
- RUGGEDNESS
- MOBILITY
- SPEED
- POWER
- DEPENDABILITY
- MANEUVERABILITY

THE CLEVELAND TRENCHER CO.
20100 ST. CLAIR AVENUE • CLEVELAND 17, OHIO

Beard joins Republic

Announcement has been made by the Republic Supply Company, Houston, Texas, of the appointment of Eugene H. Beard to its sales staff with headquarters in Tulsa, Oklahoma. Beard has had an extensive experience in the supply business. He began in West Virginia and followed the development westward, going to El Dorado, Kansas. He worked during that boom for drilling contractors and oil producers, leaving there to enter the army during the first World War. After the war he was active as field salesman and store manager in various new oil fields in Oklahoma and Kansas. He was for a time in Ponca City and Oklahoma City. Later, he lived in Pittsburgh, Pennsylvania, and Fairmont, West Virginia, calling on the trade in New York, Philadelphia, Findlay, and Chicago, as well as contacting many other points in the eastern oil fields. He was a resident of Owensboro, Kentucky, for a short period. Since moving to Tulsa seven years ago he has been active in supply circles there.

Eugene H. Beard

To new plant

Cameron Iron Works, Inc., manufacturers of oil well drilling and completion control and other special equipment for the petroleum industry, has moved into its new administrative offices and manufacturing plant situated at Katy and Silber roads in Houston, Texas.

Completion of the new Cameron plant, which includes one of the nation's largest hydraulic presses for forging steel, was announced by E. L. Lorehn, vice-president and general manager.

The main building, which measures 200 ft. wide by 600 ft. in length, houses the company's offices, manufacturing plant, and warehouse. A nucleus for the new plant was established in 1942 when Cameron constructed a plant at the Katy Road site to produce 3-in. gun barrels for the Navy. At the end of the war it was decided that Cameron's entire facilities would be concentrated there, at which time construction of the big forge shop was begun.

Prior to moving to the new location, the Cameron plant and headquarters were at 711 Milby Street for many years The company's holding on Milby Street will be offered for sale, according to Lorehn.

The company asks that all correspondence be addressed to Post Office Box 1212, Houston.

Skid tests

The 1947 National Safety Council skid tests will be held at Clintonville, Wisconsin, where facilities for the tests are being provided by The Four Wheel Drive Auto Company, according to Herman Larson, FWD experimental engineer and a member of the NSC committee on winter driving hazards.

One of the primary purposes of the tests this winter will be to obtain a comparison of the traction characteristics of a four wheel drive as compared to a two wheel drive truck. Other tests scheduled include more complete investigation of sanders and grits, and a more thorough comparison of synthetic and natural rubber tires.

The time has not been definitely set for the tests, according to Larson, but the tests will probably be held during the latter half of January. They will be under the direction of Ralph A. Moyer, professor of highway engineering, University of Iowa.

Barthmaier district mgr.

J. E. Barthmaier has been appointed district manager of the Superior Engine Division of The National Supply Company, with offices at 250 Stuart Street, Boston, Massachusetts, according to an announcement by Robert M. Pearson, manager of sales. Barthmaier has been with Superior since 1936 except for service in the Army during the last three years. While stationed at Camp Gordon Johnston, Florida, he was chief of the High Speed Marine Engine School and also was awarded a citation for organizing and placing in operation the Marine Electrician School.

J. E. Barthmaier

Testing grounds

The leasing by the International Harvester Company of a tract of 1920 acres of land near Phoenix, Arizona, as a site for experimental testing activities of industrial power equipment, was announced by H. T. Reishus, general manager of the company's Industrial Power Division, in Chicago.

The land, formerly used by General Motors as a tank testing site during the war, is approximately 23 miles from Phoenix, south of South Mountain. It has been leased for a period of five years from the Arizona State Land Department.

The area will be used as a testing ground for International Harvester's line of industrial power equipment, which includes heavy crawler tractors, power units, etc. In addition several makes of allied industrial equipment such as bulldozers, scrapers, and heavy earth moving machines used in conjunction with Harvester's line, will also be tested.

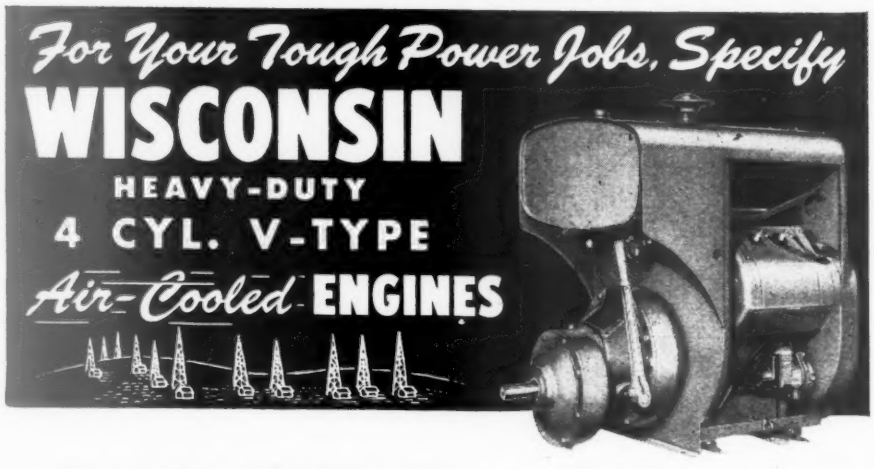
Training courses

Looking forward to the day when competitive selling will again be the order of the day in the construction equipment field, Koehring Company, Milwaukee, this month is holding the second of a series of training courses designed to supply Koehring distributor salesmen with complete up-to-date sales information on Koehring products.

Attended by approximately 35 men, representing Koehring distributors throughout the country, many of them returned war veterans new in the field, others with a lifetime of experience behind them, the 10-day refresher combines lectures by members of the Koehring sales, engineering, and management staffs with ample discussion and question-and-answer periods. Lectures are appropriately illustrated with slides, working models and movies.

Arthur E. Loder, veteran Koehring salesman and Koehring Washington representative during the war years, heads a staff of 25 lecturers including G. E. Long, president, J. R. Steelman, R. A. Beckwith, vice presidents, J. F. Robbins, Koehring sales manager, and A. E. Kelbe, sales manager, Kwik-Mix Company.

Additional schools, both for sales and service personnel, are being planned.



Here is a 475-lb. power package that delivers 30 hp. at 2000 R.P.M. — designed and built for dependable, heavy-duty service outdoors or indoors. It's the Model VP-4, V-type, 4-cylinder Wisconsin Air-Cooled Power Unit.

Compact V-type design simplifies installation on a great variety of equipment and efficient AIR-COOLING takes care of all cooling problems . . . at any season, in any location.

Heavy-duty engineering features include: Tapered roller main bearings, dynamically balanced crankshaft, mirror-finish crank-pins, honed cylinders, and molybdenum iron valve seat inserts. High tension rotary type outside magneto is equipped with Impulse Coupling for quick, easy starting in any weather.

For utmost dependability . . . specify "Wisconsin Engine". Supplied in a complete power range from 2 to 30 hp., 4-cycle, single cyl. and V-type 4-cyl. models.

WISCONSIN MOTOR Corporation
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"Oilwell" vice president

Fred F. Murray, president of Oil Well Supply Company, Dallas, Texas, U. S. Steel subsidiary, announces the election of Lloyd E. Tracy as vice president of the company. Tracy retains the position of general manager of sales.

Lloyd E. Tracy

Tracy came with Oil Well Supply Company in early 1935 from National Tube Company, another subsidiary of U. S. Steel, having joined National Tube Company in 1927. He was appointed general manager of sales of "Oilwell" in September, 1943, and is now advanced to the position of vice president and general manager of sales.

To represent in East

J. F. Bechtle, refining and chemical construction equipment specialist, has been named eastern sales representative for Texas Electric Steel Casting Company, Houston, Texas. Bechtle will maintain offices at 7 East 42nd Street, New York, Tom W. Shartle, president of Tesco, announces.

Bechtle formerly was associated with the M. W. Kellogg Company from 1923 to 1943. He was connected with the research and development, engineering, and sales division of the Kellogg company. He also served as assistant general manager at one time for the Standard Steel Corporation, Los Angeles.

Joins Ajax Iron Works

Announcement is made by Ajax Iron Works, Corry, Pennsylvania, of the appointment of Walter F. Freeman as a company sales representative. Well-known throughout the oil country for many years, Freeman has been assigned the territories of Kansas, Oklahoma, the Rocky Mountain area, Michigan, and Illinois, for his duties in connection with the sales and service of the new Ajax gas engine.

Freeman began his career as a service engineer with the Tidewater Oil Company in 1924, moving in 1930 to the Big Four Foundry Company as sales engineer, and from there in 1933 to a similar position with the Frick-Reid Supply Company, where he was engaged principally in the sale of the Joseph Reid gas engine.

Walter F. Freeman

In 1940 Freeman went to the National Supply Company as a sales engineer in the Illinois Basin and Michigan territories, and at the beginning of the war was transferred to the Superior Engine plant at Springfield as assistant works superintendent, subsequently going to Tulsa as regional manager in charge of National Supply sales and service in the Oklahoma, Kansas, and Rocky Mountain area.

In his new post, Freeman will coordinate his work with that of Harry C. Minard, long an Ajax sales representative and equally well-known in the field for his work in connection with the Ajax line of heavy duty steam drilling engines. Minard's territories include Mississippi, Louisiana, Southern Arkansas, Texas, and New Mexico.

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HOTELS

New district manager

J. D. Connor has been made district manager at St. Louis of the Superior Engine Division of The National Supply Company, according to an announcement by Robert M. Pearson, manager of sales of the division. Connor joined National Supply in 1935 after his graduation from Temple University. During the war he was chief of the Heavy Duty Diesel Engine School at Camp Gordon Johnston, Florida. He returned to inactive status last spring. Connor's office address is 1405 Boatman's Bank Building.

J. D. Connor

Heads association

Ralph B. Lloyd was reelected president of Western Oil and Gas Association, following the annual meeting of the association, December 23, at the Ambassador Hotel, Los Angeles. With his reelection Lloyd, president of Lloyd Corporation, Ltd., begins his sixth consecutive term.

Other officers elected by the association were William Reinhardt, first vice president (Union Pacific), H. D. Collier, second vice president (Standard), L. K. Whittier, treasurer (Beiridge Oil Company), Don E. Gilman, executive vice president, D. S. Kilgour, secretary, John M. Peirce, economist, and George F Prussing, technical secretary.

New firm

A new firm, Smith-Yancey Corporation, began operations January 1 with offices and plant at 3820 Winchester Street, Houston, Texas. The firm has been formed by two men well known in oil field equipment manufacturing circles, Roger Smith and J. R. (Dick) Yancey.

Roger Smith has been with Gray Tool Company for the last 20 years, was vice president and a director when he resigned on December 1. J. R. Yancey has been vice president and chief engineer of A-1 Bit and Tool Company for the last three years, and prior to that was chief engineer and then vice president of Gray Tool Company.

Smith is president of the new firm, Yancey is vice president and general manager, and Roger Smith, Jr., is secretary-treasurer.

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Wildcat high jinks

The Biltmore Bowl in Los Angeles was the scene of a typical old time prewar party on December 18, when almost 1600 oil men from all parts of the West Coast, and in all phases of the petroleum industry, gathered together for the annual letting down of hair, known as the "Wildcats Christmas Jinks." This affair, sponsored by the Western Oil and Gas Association, and organized and directed by the Wildcat Committee, is without question the leading social event of the petrolic winter season—at least in California. Coincidental with, or perhaps more correctly "just prior to" the Jinks, which begins with a dinner in the early evening, there are usually a number of independent parties held in various sections of the Biltmore, and this year was certainly no exception in that respect.

Continuing a practice — a very popular one instituted a few years ago—after dinner speeches were taboo. Bill Brooks, chairman of the Wildcats, and master of ceremonies for the evening behaved with becoming modesty and took but a scant minute or two to introduce a few visiting celebrities, among them Harry Sinclair, chairman of the board, Richfield Oil Corporation; J. A. Jameson, manager of production, Anglo-Iranian Oil Company; Joseph E. Pogue, vice president Chase National Bank of New York, and then presented the presidents or chairmen of several local petroleum organizations. After that the way was open for Carl Tuttle, chairman of entertainment for the Wildcats, to bring on his vaudeville performers, one of the best aggregations of high class professional talent ever to show before a western oil audience.

It might be pointed out perhaps that while the big annual event ran along as smoothly as a stream of lube oil, and without apparent direction, the very fact that it did was proof of the time and effort that had been put into it. Bill Brooks and his Wildcats, therefore, are to be congratulated for a fine job. It is no small matter to arrange for the feeding and entertainment of 1600 people in Los Angeles in these congested times, and the work that must go into seat sales, publicity, and all the incidentals is tremendous. All the more credit then when it is done so inconspicuously.

We happen to know, however, the time it takes to book vaudeville talent of the right sort; to handle endless correspondence and telephone calls, and to take care of all the manifold incidentals that such a program involves. It means a mighty busy season for a group of men who are already more busy than a man ought to be for his own good. Anyway, thanks to Bill Brooks, Dave Kilgour, Carl Tuttle, the Wildcat Committee generally, and let's not forget Leo Metzler of the Western Oil and Gas Association, another Christmas season was made a little more cheerful for a great many oil men, whose attendance at the Jinks is in itself proof that the work of the Widlcats *is* appreciated.

J. W. Watson promoted

Appointment of John W. Watson as vice president and treasurer of Shell Chemical Corporation was announced by J. Oostermeyer, president.

Watson is a former San Francisan, having been a member of the local staff of a national auditing firm from 1919 to 1930. He joined Shell in St. Louis in 1930 as assistant comptroller, later moving to New York as treasurer. In 1944 Watson joined Shell Chemical in San Francisco as treasurer.

In his new position he will continue to manage the corporation's financial affairs.

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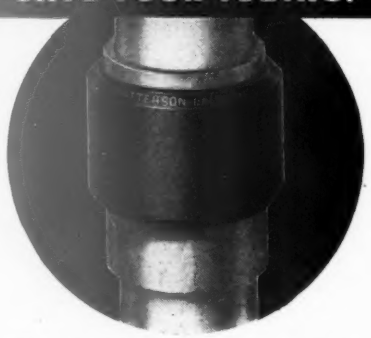

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Straube moves up

R. C. Straube

R. C. Straube, who has been regional manager for Ohio, Michigan, and Indiana for the Superior Engine Division of The National Supply Company, has been promoted to assistant to Robert M. Pearson, manager of sales of the division. Straube has had many years' experience in engineering and sales work in the diesel engine field. He joined Superior in 1935. He is well known in the diesel industry and has served on the Standard Practice Committee of the Diesel Engine Manufacturers Association.

Awarded Lucas medal

The board of directors of the American Institute of Mining and Metallurgical Engineers has announced that Dr. William Noble Lacey, by unanimous vote, has been selected to receive the Anthony F. Lucas Gold Medal for 1947. The Lucas Medal was established in 1936 to be awarded from time to time in recognition of "distinguished achievement in improving the technique and practice of finding and producing petroleum."

Dr. W. N. Lacey

Dr. Lacey was born in 1890 in San Diego, California. He holds A. B. and Ch. E. degrees from Stanford University and the degrees of M. S. and Ph.D. from the University of California at Berkeley. He began his professional career as research chemist and assistant to works manager of the Giant Powder Company of San Francisco in 1915. During 1916 he was research associate at M.I.T. Dr. Lacey came to the California Institute of Technology in 1916 as an instructor. After two years of service with the Ordnance Department as first lieutenant he returned to "Caltech" in 1919 as associate professor. He became professor in 1941 and dean of graduate studies in 1946. Dr. Lacey is consultant for several corporations. During World War II he was member of the advisory board of the Chemical Corps, U. S. Army.

At the 75th Anniversary Celebration and Annual Meeting of the American Institute of Mining and Metallurgical Engineers to be held in March, 1947, in New York City, the Lucas Medal will be formally presented to Dr. Lacey.

Coast sales manager

Appointment of Harold P. Curtis as Pacific Coast sales manager of The Babcock and Wilcox Tube Company was announced at the main office of the company at Beaver Falls, Pennsylvania. Curtis' headquarters are in the Banks-Huntley Building, 634 South Spring Street, Los Angeles.

Before taking this position, Curtis was Pacific Coast sales manager for Rustless Iron and Steel Corporation of Baltimore. He was associated with the Columbia Steel Company for eight years, and became manager of its stainless steel sales in the southern California area. Curtis then joined the Budd Manufacturing Company, working on the Pacific Coast, and later was appointed general sales manager of the Budd company in Philadelphia.

The San Francisco territory and northern California area will continue to be served by Kilsby and Harmon, Inc., as sales representatives of The Babcock and Wilcox Tube Company. In the Los Angeles area, Kilsby and Harmon, who used to represent the tube company exclusively, will now act as jobbers for certain seamless and welded specialty tubing products of the company and as mill representatives on certain other products into which their present activities will bring them.

Heads NGAA committee

H. W. Harts, vice president of Warren Petroleum Corporation, Tulsa, Oklahoma, is to head the 1947 convention program committee of the Natural Gasoline Association of America, according to a recent announcement of William F. Lowe, NGAA secretary. The convention is to be held April 23-25 in the Baker Hotel, Dallas.

H. W. Harts

Others appointed to serve on this committee by NGAA President J. H. Dunn, Shamrock Oil and Gas Corporation, Amarillo, include the following: W. L. Bowser, Atlantic Refining Company, Dallas; F. B. Haverfield, Continental Oil Company, Ponca City; Max Lents, J. S. Abercrombie Company, Houston; James E. Pew, Sun Oil Company, Philadelphia; W. H. Vaughan, Tidewater Associated Oil Company, Houston, and C. R. Williams, The Chicago Corporation, Corpus Christi.

A.S.M.E. honors Leeds

Morris Evans Leeds, pioneer in the development of modern electrical instruments and in the field of industrial relations recently received the highest honor of the American Society of Mechanical Engineers, the ASME Medal. The medal was presented by D. Robert Yarnall, ASME president, at the society's annual banquet at the Hotel Pennsylvania.

Leeds, founder and chairman of the board of the Leeds & Northrup Company, of Philadelphia, is the inventor of the "Leeds mechanism," a basic element in the automatically-operated balanced-current recording and controlling instruments.

W.P.R.A. meeting

The Thirty-Fifth Annual Meeting of the Western Petroleum Refiners Association, scheduled for San Antonio, Texas, March 24, 25, and 26, promises to be one of the most successful meetings ever held.

H. T. Ashton, Socony-Vacuum Oil Company, St. Louis, Missouri, president of the association, announces the program as rapidly nearing completion.

Notable speakers have been obtained for the general sessions of the meeting, and among them is the Honorable Beauford H. Jester, Governor of Texas. Governor Jester will deliver the "Address of Welcome" to the visitors on Tuesday afternoon's general session.

Also appearing on the program of the general sessions will be John L. McCaffrey, president of International Harvester Company. McCaffrey will speak on the intimate relationship between the agricultural and petroleum industries.

The manufacturing committee of the

association, in charge of the technical sessions to be held on the mornings of March 25 and 26, have completed a tentative program that includes papers and discussions on such timely subjects as petro-chemicals, Fischer-Tropsch synthesis, octane requirements of automotive engines, and catalytic cracking. The names of the speakers, together with the exact titles of the papers will be announced at an early date.

Pioneers' party

Defying that old "Friday the Thirteenth" jinx, four hundred Petroleum Production Pioneers gathered in the Rodger Young Auditorium in Los Angeles, on Friday, December 13, and took part in one of the most interesting affairs ever staged by the organization. Under the chairmanship of J. E. Gosline, Standard of California's southern division manager, the so-called "Year-End Party" opened with a social period.

Following the social period, an excellent dinner was served, with charcoal broiled steaks hot off the grills, and all the customary trimmings. At the close of the dinner, Chairman Gosline briefly defined the progress of the organization over the past year, and presented some insight into the more important aims and objectives of the future. He then called upon F. F. Hill, honorary president, who led a panel of old timers in a discussion of early oil field practices. In this he was aided by Walter English, Continental Air Map Company.

Denny Driscoll of Baash-Ross Tool Company was delegated to talk briefly on early drilling tools, which he did eloquently and interestingly.

Frank Hill, former director of production for Union Oil Company of California, took as his own subject in the panel discussion "the development of oil well cementing," with the first uses of which in California he was intimately connected.

Among other speakers was W. L. McLaine, General Petroleum Corporation, who was recently elected honorary vice president for 1947 and will take over after the first of the year. He urged the Pioneers to exercise themselves toward the establishment of downtown headquarters, where the members could meet as they desired, and where the business of the organization could be carried on conveniently and comfortably.

W. R. "Dick" Guiberson, next year's honorary president, made a forceful appeal for the institution of a petroleum museum, in which might be exhibited items such as unusual equipment and tools; pictures and documents of historical value, and a reference library of petroleum books and publications. He also proposed the setting aside of one of the old discovery sites in the Los Angeles area as an ideal locale for such an institution as well as a monument to the petroleum business.

At the conclusion of the panel discussion, the meeting was turned over to Lou Bronzan of Baash-Ross Tool Company, entertainment chairman, who presented a high class professional vaudeville show, in which much of the fun was the result of audience participation.

During the evening it was disclosed that Elmer Decker, Martin-Decker Corporation, had been elected to the executive board for 1947. The board will then consist of the following members: F. F. Hill, W. R. Guiberson, W. L. McLaine, J. E. Gosline, B. Bronzan. T. A. Atkinson, S. H. Grinnell, O. W. Morgan, Jr., E. W. Webb, C. S. Perkins, J. J. Siegel, A. S. Hayes, L. G. Trembley, Ted Sutter, R. Sneddon, and Elmer Decker. New officers of the organization will be elected at an executive committee meeting to be held some time before February 15, 1947.

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In view of the chummy relationship that now prevails between the petroleum industry and agriculture, it is interesting to learn that the Oil Producers' Agency of California has for some ten years been fostering a program aimed at the cultivation of the Yerba Santa. From this plant, according to Rush Blodget, is derived vitamin P, used by the medical profession "for thickening cell walls and to prevent the occurrence of blood leakage and hemorrhage, with particular emphasis on eye tissues." If this weren't an unusually dignified column we would be tempted to inform Rush that beer is also reputed to be highly productive of vitamin P.

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A letter from George O. Suman, Tide Water Associated production chief up in the San Joaquin Valley, opens with a communistic "Dear Red," and suggests that the Production Pioneers call themselves the "Petrified Philopteroid Party." This unwarranted barrage of polysyllabics was called forth by the secretary's admission that he had made a common or garden mistake, and was in consequence wearing "a red face." Until it is determined whether a "philopteroid" is a nasty name or a scientific species, no action will be taken, but if it means anything like some people are guessing, there is a pronounced likelihood that libel proceedings will be instituted, and that Comrade Suman's outburst will have repercussions. Meantime, it might be pointed out that George is himself a member of the organization, so that what vituperation he heaps on it he coincidentally heaps on himself.

•

Word comes as we write that Roy Collom, one of the best known and best liked western oil executives, manager of Continental Oil Company's California operations, and a vice president, has resigned these positions, but will continue to officiate as president of Kettleman North Dome Association, and as a director of both organizations. Roy has always evinced an intense interest in Indian lore, being especially intrigued by the behavior of the Stanford Indians. This is quite understandable, since he himself is a graduate of the Palo Alto institute of higher education. The reason for his partial resignation, we understand, is that for years he has been sadly neglecting some very interesting hobbies. For example, there are some wonderful scenes, petrolic and otherwise, that are waiting anxiously to be photographed in color, and there are some trout pools that have remained altogether too long unmolested. These conditions Mr. Collom intends to change forthwith, and in this worthy ambition we wish him *bon chance*. (By gosh; French—whaddyu know?)

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One of the really up and coming young production engineers of the California oil industry is T. A. Atkinson, assistant to the division superintendent of General Petroleum Corporation, a personable sort of a lad who has more energy than a can of Uranium 238. Tom is a director of the AIME, is on the executive board of the Petroleum Production Pioneers, is an extremely studious individual, and seems to be alive to every consequential development in field practice. On rare occasions, however, he dashes off to the woods with Johnny Hills, Jim Moon, Ben Bayliss, Fred Hummell, John De Hetre, and other congenial souls, and on the banks of some woodland stream engages in a fishing job that has nothing to do with drilling operations, and is vastly more restful. This capacity to dissociate himself completely from the derrick and the doghouse for a spell, be it ever so brief, is the thing that keeps Tom's mental processes free from sludging, as it were, and enables him to maintain the keen analytical discernment that is no doubt responsible for his elevated position.

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Away up in the North Round Mountain district is another young fellow, an engineer by the name of Will Dunlap, who despite his 74 years of strenuous living, has enough zip to do his daily stint at the tank farm, and some left over to compose popular songs. By mail the other day we received a copy of his latest opus, "In The Land We Call Our Own—California." After several hours practice, we were able to do a pretty good job of playing it on our Steinway with the middle finger of the right hand. It is a nice tuneful song and we have played it so often since it came to us, that the family in the next apartment have already had a ten dollar reduction in their rent. All of which reminds us that we once had ambitions to be a composer. The first thing we ever did was a lovely piece called Hungarian Rhapsody No. 2, and just after we had finished composing it, we found it had already been done by a foreigner, named Franz Liszt. We were so despondent over this shock that when an offer finally came to go into the oil business, we were too weak to refuse it.

Clarence Hill, assistant to the division manager, and just rounding out his 40th year with Oil Well Supply Company, was within an ace of going into the hay and grain business in Coalinga away back in 1905, but he succumbed to the appeal of the oil fields, and neither he nor the oil industry has ever regretted the decision. Clarence is what we used to call in our Latin class, a *rara avis* or native Californian. He doesn't believe in heaven or hell, but just thinks that all the people who have lived good lives will eventually be allowed to live in California, while the ones who have been naughty will be consigned to—well, that's a controversial subject, and has no place in a peaceful column like this. Anyway, to return to the hay and grain business, it is not unlikely that if he had taken it up he would have come in contact with oil men just the same. We remember some time ago reading a letter from Lyman Stewart to the several operating department heads of Union Oil Company, deploring the heavy expenditures for hay and feed, and exhorting all the "ostlers" to be a little less generous to the horses and mules that were then functioning in lieu of cars and trucks.

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R. C. "Reg" Stoner, vice president and director of Standard of California, is also claimed by California as a native son. He was born in the capital (there may be some dispute about this) of the San Joaquin Valley—Bakersfield, and is a graduate geologist from the University of California, where he established a great reputation as a catcher on the Varsity baseball team. He was a potent factor in the historical seventeen inning defeat of Stanford in 1909. Pardon the intrusion, but we were one of the outstanding fielders on our own college baseball nine. Being built very close to the earth, we were able to scoop up grounders without stooping—a very important attribute in a game where split-second decisions often meant the difference between victory and defeat. Continuing on the main topic, however, Mr. Stoner seems to have a flair for getting into interesting occupations. Immediately after graduation, he did excavation work at the La Brea tar pits, and in the 34 years, more or less,that he has since been with Standard of California, he has been credited with some of the state's most productive exploration and development. He was elected to a vice presidency in Standard in 1941 and is at the present time a director in the API. His favorite diversion is hunting—big game hunting—like the big game between Stanford and U. C.

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In the first days of what we laughingly refer to as our petrolic career, we became acquainted with a group of young technicians who were then compiling laboratory data to be used in a cracking process infringement suit. These boys have since been scattered high, wide and handsome, but of one at least we have been able to keep fairly close track—that is, Verne Taylor superintendent of distillation at Union Oil Company's Oleum refinery. Verne was always a quiet, scholarly sort of a fellow with a great interest in things literary, and particularly anything that referred to the early history of the United States. Indeed, he has at the present time, one of the best private libraries in the state on this subject. When he can tear himself away from the stills long enough, nothing pleases him better than to hie out to his cabin at Downieville for a chestful of hydrocarbon free air, and a bit of fly fishing with one of Maynard Reynold's Royal Coachmen. It is probably exaggerated, but they say he throws back every fish over nine inches long, because that is the diameter of his frying pan.

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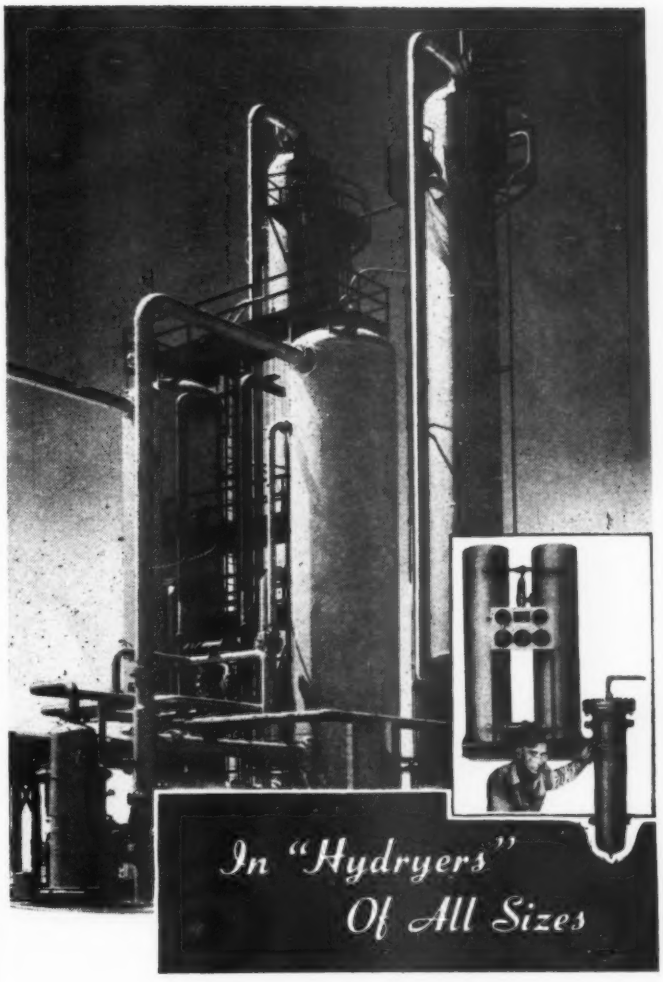
It is good news that Frank Colton, manager of Tide Water Associated's gas department, is back home from the hospital recuperating from a severe case of spinal meningitis, and is making very satisfactory recovery. Frank, who is vice president of California Natural Gasoline Association, is one of the petroleum industry's best golfers, and comes in ordinarily with the same score for 18 holes as we usually get in 9. He is so near professional caliber, in fact, that there is talk of handicapping him in the annual CNGA tournaments by making him a member of the technical committee. That, it is estimated, will increase any man's score by at least four strokes a hole, and almost take him into the class of Walt Dayhuff. Be all that as it may, however, our very best wishes to Frank, and the sincere hope that he will quickly be back on the beam.

•

We hear on good authority that Charley Bevan, superintendent of Standard of Cal's Kettleman natural gas operations is in the process of jumping over to Arabian American, and will in future be located in Saudi Arabia as manager of stores. Charley is an adventurous sort of an individudal. He is a Stanford alumnus, was engaged in tank service during the first World War, was brought back home to teach the new recruits something about tank warfare, and on the way back was torpedoed. He has been active in Oklahoma, Texas, and California, and is as well known among the nation's natural gasoline men as is the boiling point of butane. Charley's favorite sport is horseback riding, but he will probably have to take to the camels from now on. That fortunately should present no great difficulty. We are told by experts that riding on a camel is just like being on a horse that has swallowed its saddle.



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Book Reviews

● **The Valley of Oil,** *by Harry Botsford. Published by Hastings House Publisher, 67 West 44th Street, New York, New York. Price, $3.00. Pages, 278.*

A one-time contributor to *The Petroleum Engineer,* Harry Botsford, turns from his present day life and career in the oil business to write a story of the pioneer oil men in Pennsylvania.

The story of "Colonel" Edwin L. Drake, the founder of the petroleum industry, has a new slant on that enduring character. The second part of the book views the Phantom City of Pithole, following it from its roaring youth to its flaming death in 1866.

In the third section the men and women of Pithole are intimately portrayed. Lusty, colorful, and sometimes strange, these characters do nothing to lessen the tradition of spirit, vigor, and excitement found in and around the oil fields.

All this and more is to be found in this vivid chronicle of the early growth of the world's first commercial oil enterprises and the pioneers in Pennsylvania who launched a lusty, new industry in the late 19th century.

● **Explosion and Combustion Processes in Gases,** *by Wilhelm Jost. Translated by Huber O. Croft. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York 18, New York. Price, $7.50. Pages, 621.*

A translation of the classic German work on jet propulsion. This book presents the experimental and theoretical facts underlying explosion and combustion processes in gases. It serves as an introduction to the field, and is also of great practical value to those doing research in the various allied fields. A broad theoretical basis has been provided, as well as a detailed description of recent experimental work allowing the physical chemist to form his own conclusion independently of the theories of the author.

● **Rarer Metals,** *by J. De Ment and H. C. Dake. Published by the Chemical Publishing Company, Inc., 26 Court Street, Brooklyn 2, New York. Pages, 432. Price, $7.50.*

A concise book in which the mineralogy, chemistry, physics, and technology of the less familiar elements are described, this volume correlates basic data on rarer metals for the busy professional man and the student.

Excluding the metals of the rare earths on which there is extensive literature, some twenty elements are discussed briefly; also some of the interesting and important practical applications of these elements.

The book gives a survey of newer tests, such as those of microchemistry and fluorochemistry rather than a review of analytical methods. The stress has been laid upon specific tests, which can be performed rapidly with simple equipment and satisfactory results.

● **Petroleum Production Engineering, Oil Field Development,** *by Lester Charles Uren. Published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, New York. Pages, 764. Price, $7.00.*

In this revised and expanded third edition of "Oil Field Development," an effort has been made to bring together the more important information relating to each phase of the oil producing industry and to interpret the major facts in terms of the requirements of individuals interested in the whole rather than in the special subdivisions thereof.

The volume sketches briefly the problems of petroleum exploration, discusses the principles and practices of oil field development and describes the methods and equipment used in modern well drilling. The manner of presentation of the data follows that developed by the author in the conduct of petroleum engineering courses in the University of California. The needs of the petroleum engineering student as well as the oil company executive have been well considered.

Some material in this volume is reprinted from *The Petroleum Engineer,* for which it was originally prepared by the author.

● **American Petroleum Refining,** *by H. S. Bell. Published by D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York. Pages, 619. Price, $7.50.*

This third edition provides a concise summary of the art of petroleum refining in its many and varied phases. The opening chapters discuss briefly the history of petroleum refining and the characteristics of crude oil. Other chapters cover various subjects, among them, heat transfer, shell stills, pipe heaters, condensers and heat exchangers, fractionation, thermal and catalytic cracking, chemical treatment, dewaxing, solvent extraction, and the general departments.

The last chapter considers the problem of the future and our supplies of petroleum. The author reviews the possible sources of oil and the hydrogenation of coal, gas synthesis, and extraction from shale, not overlooking the estimated production costs.

During the last decade technique has progressed at the most rapid

rate in the history of the industry. The purpose of this volume is to combine the information and to make it readily available to the executive, engineer, or employee seeking up-to-date facts.

Union Oil sells shops

Simultaneously with the disclosure that the Santa Fe Drilling Company has taken over Union Oil Company's drilling facilities, and that the latter will henceforth have all of its drilling done by contract operators, it is announced that Union's service and maintenance shops and equipment, consisting of welding shop, electrical shop, carpenter shop, paint shop, boiler shop, and incidental transportation, have been purchased by Key Contractors, Inc., which with H. E. "Bud" Giles, as president, will begin contract work in its own behalf February 1, 1947. The concluding move in the general plan is the sale by Union Oil Company of its salvage and pipe shops, at Santa Fe Springs, to Dave Hearn. This too, becomes effective February 1, 1947.

Union Oil Company has made no statement with respect to the elimination of its drilling department, the prospective transfer of some 500 employes to new and independent organizations, and future recourse to contract drilling, but it is certain that the decision to take such steps was reached only after long and careful consideration. It is merely speculative perhaps, but it seems rather obvious that the piling up of large drilling equipment inventories to handle temporary drilling peaks, and the subsequent storage of such equipment during periods of relative inactivity, might cause excessively high depreciation and obsolescence costs, and thus, *in toto*, be distinctly uneconomical. It also seems a fair assumption that the highly competitive nature of contract drilling has in time tended to reduce quoted footage costs to a relatively attractive level.

Regardless of the reason, however, for this interesting change in policy, the opportunity for ownership that it has offered to employes, demonstrates in a very tangible way that monopoly is not such an obsession with the industrialists as the mutterers would have us believe, and that there is still in this country worthwhile opening, even executive aid and encouragement, for the institution of new, independent business. In brief, where it is properly nurtured, the system of free enterprise still flourishes.

Persons sales manager

J. F. Lincoln, president of The Lincoln Electric Company, announces the appointment of W. R. Persons as sales manager of the company.

Persons assumes his new position immediately, reporting to C. M. Taylor, recently advanced to executive vice president.

W. R. Persons

Persons has had a broad sales experience with the company. After a brief period in boiler shop fabrication work, he became interested in arc welding and urged the company for a chance during the bottom of the depression, 1934. No jobs being available, he trained and graduated from the famous Lincoln Welding School (as do all Lincoln salesmen today) and finally was sent as a welding demonstrator to the company's Pittsburgh office. After some time as a sales and service man in western Pennsylvania, he became district manager at Pittsburgh in 1937. He served in that capacity until his recall to Cleveland for a special postwar planning assignment. From this assignment he was promoted to his present position with the company. In 1932, Persons graduated from the Case Institute of Technology with a degree of M.S. in engineering, and while attending Case, he took an active part in athletics. He was a member of both Sigma Xi, honorary fraternity, and Sigma Alpha Epsilon, social fraternity.

I.S.A.P. Congress postponed

The Peruvian Section of the Southamerican Petroleum Institute, which has undertaken the organization of the First Southamerican Oil Congress, has asked the Central Bodies of the I.S.A.P. to postpone the Congress until May. The main object of this change is to facilitate visits to the oilfields and to the City of Cuzco, which hardly could be made in March, during the rainy season, with climatic conditions entirely inadequate for airway trips across the area.

The International Permanent Council has decided that the Lima Congress be held on May 12-17 and the tours and visits have been scheduled for the week previous and the week subsequent to the Congress.

The Venezuelan Government has recently decided, through its Ministerio de Fomento, to be represented at the Congress. Other countries already had announced they would be represented.

Firm name changed

Bechtel Brothers McCone Company, San Francisco, California, has changed its name to Bechtel Corporation. Names of its subsidiaries have been changed to Bechtel International Corporation, Compania Bechtel, S. A., and International Bechtel, Inc.

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G. P. Hough promoted

The A. O. Smith Corporation announces that George P. Hough has been appointed executive administrator of the company's Chicago district, taking the place of Don T. Allen who resigned recently.

G. P. Hough

Hough has been with the company since 1939. He entered the Chicago office in that year to direct the sale of pressure vessels that the company manufactures for the oil refining industry and the paper and chemical industries.

His activities kept pace with the increasing sales volume of the Chicago office, as the company expanded into such fields as welding electrodes and equipment, and consumer products such as glass-lined water heaters and domestic coal stokers. In 1944 Hough was appointed assistant administrator in direct charge of several sales activities. Today, with six product sales managers and a force of 35, he will direct all sales for the company's products in the ten Middle-western states.

Continental appointments

The Continental Supply Company has named R. L. Collier district manager of the North and West Texas-New Mexico district, succeeding T. D. Collins, resigned. Headquarters for the district is at Fort Worth. Collier has been with the Continental organization since 1925, beginning as stenographer-bookkeeper. He was made manager of the Corsicana, Texas, store in 1926. Later he served as manager of the Mexia and Refugio, Texas, stores. In 1934 he was made assistant district manager of South and Southwest Texas district with headquarters in Corsicana.

Continental also announced appointment of A. P. Lacey as assistant district manager of the South and Southwest Texas district, effective January 1. Lacey formerly served in the same capacity in South Louisiana for the company. He succeeds R. L. Collier. Lacey will make his headquarters at Corpus Christi, Texas.

Charles A. Coffin awards

Ninety-five employes of the General Electric Company who performed work of outstanding merit during the four war years 1942 through 1945, received Charles A. Coffin awards for their accomplishments, it is announced by Charles E. Wilson, G-E president.

Named for the first president and one of the founders of the General Electric Company, the Charles A. Coffin awards, the company's highest awards, carry a certificate and a cash honorarium. They provide recognition by the company of accomplishments of unusual merit by employes engaged in all types of work. The 95 awards involve 66 separate accomplishments, 23 of them joint accomplishments by two or more persons.

Highest number of the awards, 68, went to employes of the G-E apparatus department, largest of the company's six operating departments. The general engineering and consulting laboratory received 11; appliance and merchandise department, 10; electronics department 3; air conditioning department, 2; chemical department, 1.

Interest in Lincoln Foundation program

Inquiries from every state of the union and from 27 foreign nations indicate an unprecedented interest in the $200,000 Design-for-Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio.

These inquiries, regarding the rules and regulations of the program, have been arriving daily since the program was announced in June of last year, and now number in tens of thousands.

The program, having the double purpose of stimulating scientific research and design involving arc welding and of making the results of these studies available generally, closes on June 1, 1947.

The present program provides 452 awards totalling $200,000 for papers embracing every field of industry and research where arc welding may be applied, and in scope is comprised of 15 classifications and 43 divisions, which have been established to permit wider participation for the entrants.

Executive secretary association

The newly elected executive committee of the Rocky Mountain Oil and Gas Association has named Frank C. Fogarty executive secretary to fill the vacancy made when H. O. "Tex" English resigned to accept the managership of the oil department of the Casper National Bank.

Fogarty has been active in various branches of the oil industry continuously in the Rocky Mountain area for the last 15 years.

Heads diesel association

E. J. Schwanhausser, vice president of Worthington Pump and Machinery Corporation, was re-elected president of the Diesel Engine Manufacturers Association at the association's annual meeting held recently in Chicago.

Also returned to their posts as vice presidents of the association were J. E. Peterson, vice president of General Machinery Corpora-

tion, and Gordon Lefebvre, president of Cooper-Bessemer Corporation. Robert H. Morse, Jr., vice president and general sales manager of Fairbanks, Morse and Company, was again chosen to serve as treasurer.

Directors were elected as follows: William E. Corrigan, vice president of American Locomotive Company; George W. Codrington, vice president of General Motors Corporation and general manager, Cleveland Diesel Engine Division; A. W. McKinney, vice president and general manager of sales, National Supply Company; Robert E. Friend, president, Nordberg Manufacturing Company; Norris H. Schwenk, president of Busch-Sulzer Brothers-Diesel Engine Company; and G. F. Twist, vice president and general manager, Atlas Imperial Diesel Engine Company.

Harvey T. Hill, who for three years has been executive director of Diesel Engine Manufacturers Association, was appointed to continue in that capacity.

Service records awarded

At a dinner given to American Meter Company's 25 year Service Guild members at the DeWitt Clinton Hotel, Albany, New York, Norton McKean, president, awarded recognition to five new members of the Guild from the D. McDonald Works at Albany. The Guild in the Albany plant now has 72 members, comprising approximately 14 per cent of the personnel.

The five who were the latest to qualify for the honors to which their quarter century of continuous service has entitled them are Leo Rivers, George A. Nicklas, George W. Winne, Arthur M. Manweiler, and Charles C. Schlosser. Bernard J. Holtslag is senior in point of service, having joined the company in 1886.

T. D. Collins joins Ideco

Appointment of T. D. Collins as vice president, Mid-Continent direct sales, has been announced by O. M. Havekotte, president, International Derrick and Equipment Company. Collins makes his headquarters in the Ideco Building, Dallas, Texas.

In 1927, Collins entered the oil field supply business with Continental Supply Company at Ranger, Texas. During his 20 years with Continental his activities were confined largely to the Mid-Continent and Rocky Mountain areas. He was assistant district manager in West Texas when he was placed in charge of the Rocky Mountain division. Before joining Ideco, he was in charge of West Texas, North Texas, and New Mexico divisions.

As vice president of Ideco, Collins is in charge of supply stores and direct sales in the Mid-Continent, Gulf Coast, Rocky Mountain, and Illinois divisions.

Jack Pew succeeds father

Sun Oil Company's board of directors has elected John Glenn (Jack) Pew vice president in charge of production and Francis S. McIlhenny, Jr., secretary-treasurer, President J. Howard Pew has announced.

Jack Pew, who has been associated with oil field operations in Texas, Oklahoma, and Louisiana for almost 25 years, succeeds his father, J. Edgar Pew, who died November 22, 1946. He has been a director of Sun Oil Company and assistant to the vice president in charge of production since 1941.

It was announced simultaneously at Dallas, Texas, that Pew had also been elected president of the Sun Pipe Line Company, (Texas) a subsidiary of Sun Oil Company.

McIlhenny, who was also named a director, succeeds Mr. Cross, who died November 25, 1946, after serving as secretary-treasurer for more than 40 years. McIlhenny thus becomes the second person to hold the position of secretary in Sun Oil Company.

Pew was born in Beaumont, Texas, May 14, 1902. He attended Southern Methodist University, Cornell University, and Massachusetts Institute of Technology.

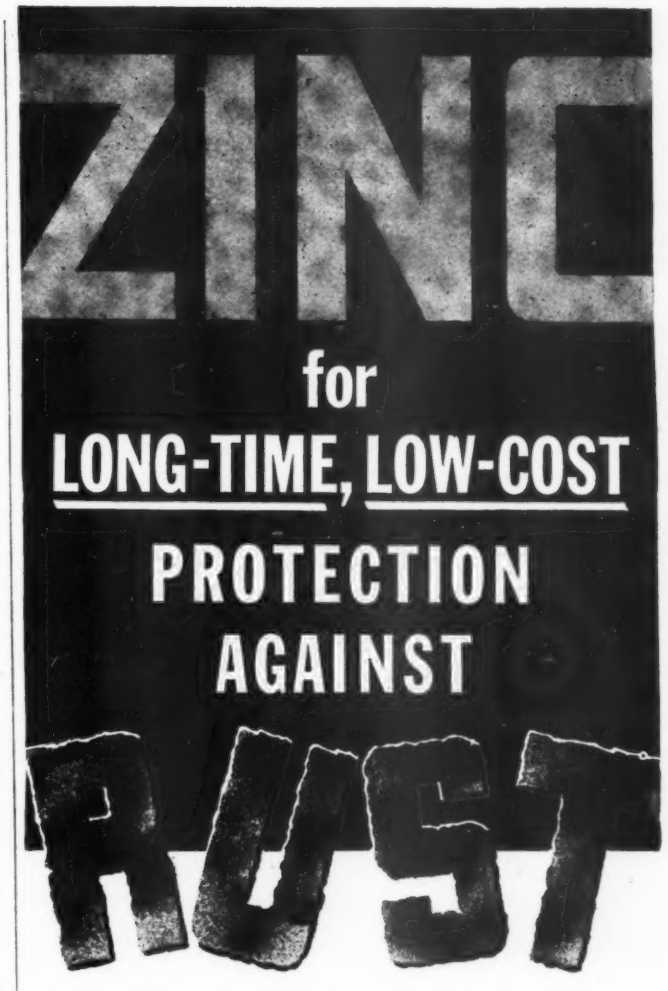
During summer vacations he worked in Texas oil fields and after college entered Sun Oil Company's production department as warehouseman and timekeeper at Wortham, Texas. He held a variety of positions in the land and production departments in the years that followed. His home is in Dallas, Texas.

McIlhenney, who is 36, is a graduate of Princeton University and the University of Pennsylvania Law School. He joined Sun Oil Company's treasury department in 1939 after having been associated with the MacCoy, Brittain, Evans and Lewis law firm in Philadelphia for several years.

Director public relations

Announcement has been made by Charles J. Hardy, chairman of the board, American Car and Foundry Company, that Arthur Tuckerman has been appointed director of public relations for the company.

In January, 1945, after his release as a lieutenant commander in the U. S. Naval Reserve, in which he served as liaison officer both overseas and in the Third Naval District, Tuckerman joined ACF as assistant to executive vice president Charles J. Hardy, Jr., in the field of public relations.



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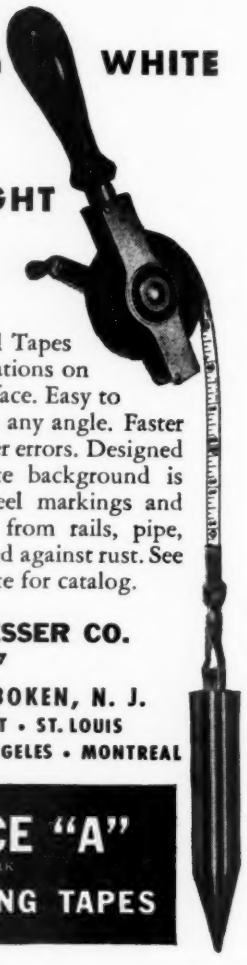

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New committee formed

Organization of the National Oil and Gas Committee was announced here Saturday when committee officers chose Dallas for headquarters and set up offices here.

Formed to foster the general interests of the oil and gas industry and particularly to keep abreast of developments relating to the Federal Natural Gas Act and the gas investigations recently concluded by the Federal Power Commission, the committee is headed by Major B. A. Hardey of Shreveport, Louisiana and Joseph Bowes of Tulsa, Oklahoma, as co-chairmen. Officials of leading petroleum associations organizing the committee include Major Hardey, president Independent Petroleum Association of America; Bowes, president Independent Natural Gas Association of America; Jake L. Hamon of Dallas, vice president American Petroleum Institute; Frank M. Porter of Oklahoma City, president Mid-Continent Oil and Gas Association, and Robert Hendee of Colorado Springs, Colorado, representing the American Gas Association.

"The oil and gas industry throughout the nation has become very much alarmed concerning the action of the Federal Power Commission under the Natural Gas Act and court decisions pertaining to such action," Co-Chairmen Hardey and Bowes said in a joint statement. "These threaten to place producing and gathering operations on a public utility status and likewise threaten to control the use to which gas is put.

"To correct the situation, the National Oil and Gas Committee favors the enactment of an amendment to the Natural Gas Act in order to deny to the FPC any authority to regulate production and gathering; the price at which the producer and gatherer sell gas; and the purposes for which natural gas may be sold or used. The committee also favors limiting rigidly the jurisdiction of the FPC to interstate trunk-line transportation of gas and to the sale of gas for resale for public consumption after such transportation is completed."

To receive Hoover Medal

Dr. Vannevar Bush, president of Carnegie Institution of Washington, and wartime director of the Office of Scientific Research and Development, has been named 1946 winner of the Hoover Medal, jointly awarded by four national engineering societies. The medal is of gold and bears the inscription: "Awarded by Engineers to a Fellow-Engineer for Distinguished Public Service."

It will be formally conferred on Dr. Bush on Thursday, January 30, at 1:45 p. m. in the auditorium of the Engineering Societies Building, 29 West 39th Street, New York, at the winter meeting of the American Institute of Electrical Engineers. This society confers the award jointly with the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, and The American Society of Mechanical Engineers.

Firm dissolved

K. B. Nowels, of Abilene, Texas, formerly associated with J. C. Hunter and J. C. Hunter, Jr., in the partnership of Hunter, Nowels and Hunter, specializing in water flooding and other secondary recovery projects with offices in Abilene, Texas, has announced the dissolution of that firm.

Since the death of Judge Hunter in November, 1945, it became necessary to dissolve the partnership and their properties in Oklahoma and Texas have been acquired by Hill and Hill, prominent independent oil operators of Fort Worth, Texas. Nowels retains his interest in these properties and has supervision of them.

W. B. Scott promoted

P. V. Galvin, president and founder of the Galvin Manufacturing Corporation of Chicago, announces the appointment of Walter B. Scott of Chicago, to the position of assistant to Mr. Povlsen, who is assistant to the president.

Scott was formerly assistant to the vice president in charge of production for the J. I. Case Company, of Racine, Wisconsin. He worked in wage rates and methods for the American Can Company prior to that time. A graduate of Drake University, Scott holds a bachelor of science degree in factory management.

New manager Chicago branch

R. H. Morse, Jr., vice president and general sales manager of Fairbanks, Morse and Company, Chicago, has announced the appointment of John S. King as manager of the Chicago branch house of the company, succeeding Frank V. Roy who retires from that position, which he has long held, on March 1, 1947.

King joined the company as a student in the Beloit plant where he assembled and tested pumping equipment and diesel engines. In 1921 he was transferred to the Indianapolis works of the company, building electric motors and generators. A year later he joined the sales force of the Chicago branch, working as territorial representative on pumping equipment until, in 1930, he was made manager of the pump department of that branch. In 1937 he was appointed manager of the firm's New Orleans branch.

Later in 1945 he was recalled to the executive staff at Chicago where he was successively manager of the pump division and assistant

manager of the railroad division, which latter position he fulfilled with great success until his present appointment.

Roy, who joined the Fairbanks-Morse organization in 1908, has had a long and successful career. He has served honorably with outstanding success in a number of high executive positions.

Arc welding film

"Design for Arc Welded Structures" is a new motion picture produced to assist architects, engineers, contractors, and others in the structural field to visualize the improvements in design and construction that are made possible by using arc welding. Directed by The Lincoln Electric Company, this color sound movie is another in the series of educational motion pictures completed by the company.

Humorously portraying a cave man's first attempt to join a structure with thongs, the film reviews the development of fastening methods . . . wooden pegs, then nails and, as structural steel replaced wood, by bolts, nuts and rivets. Each of these methods of fastening had definite limitations but with the development of arc welding, the film shows how the designer now has unlimited freedom of design.

How arc welding permits simplified design, new freedom in planning, reduces steel tonnage and also simplifies detailing, fabrication, and erection is all clearly seen. The picture also explains the tremendous possibilities of tubular construction and rigid frame design for more efficient use of materials and better appearance.

The film, which has a running time of approximately 15 minutes and was produced by Herb Lamb Productions, is available in 16 mm. sound color prints from The Lincoln Electric Company, 12818 Coit Road, Cleveland 1, Ohio, at no charge except for transportation.

Move headquarters

Operating headquarters of Cities Service Gas Company will be moved to Wichita, Kansas, in March of 1947, it is announced by S. B. Irelan, president. Quarters will be on the fifth floor of the downtown office building at 202-212 North Market Street.

Operations of the Cities Service Gas Company system comprising 5000 miles of pipe line and more than 100,000 hp. of compressor station capacity have been conducted since 1912 from headquarters in Bartlesville, Oklahoma.

Location of the company's operating staff and office facilities in Wichita will move 75 executives, supervisors, and other employes. Legal and sales offices maintained in Wichita for several years will be housed with the operating staff in the new quarters. Garage and meter shop facilities for the pipe-line system also will be moved from Bartlesville to Wichita.

Upon completion of the Wichita move, the Kansas community will become operating hub of a far-flung natural gas system extending from northern Texas and western Oklahoma to Kansas, Missouri, and Nebraska. The company delivers gas at wholesale to 290 cities, towns, and small communities in the service area, and to nearly 1800 industrial customers. Total population of the area served is more than 1,529,000 and gas is supplied to approximately 386,000 customers by local distribution companies.

The company recently filed application with the Federal Power Commission for authority to construct 405 miles of 26-in line from the Hugoton field in western Kansas, northeast across the state to Kansas City. The line will substantially increase the supply of gas for the company's principal markets in Kansas and Missouri. It is expected that actual construction of the proposed new line will begin in April of 1947, with completion scheduled the fall of the same year. Construction headquarters of this line will be established in Wichita as the project gets under way.

Made division manager

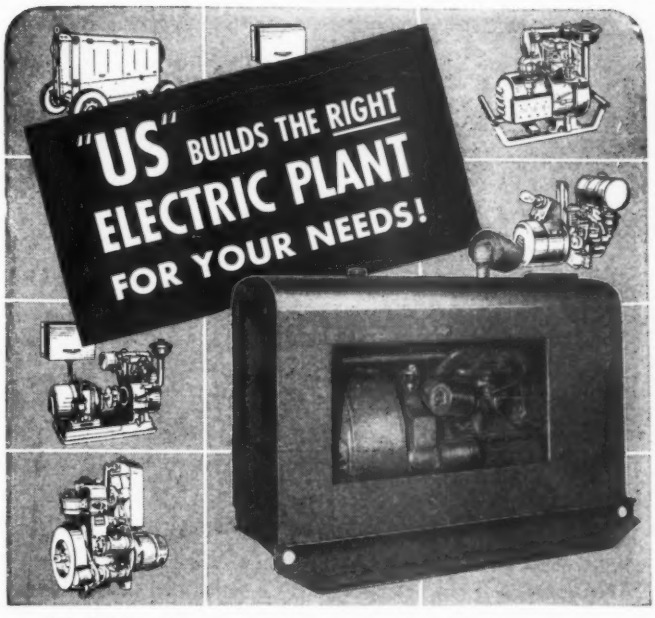
J. W. (Pete) Gillespie, who has been manager of the Wyoming-Montana district of The National Supply Company since 1924, has been appointed manager of the Northwest Division, according to an announcement by A. W. McKinney, vice president and general manager of sales. Gillespie succeeds I. G. Wetherill, who is retiring after 45 years with National Supply.

At the same time the company's division headquarters is being moved from Denver to Casper, Wyoming, McKinney said. This move is being maade because of existing company-owned facilities at Casper and because it is centrally situated in Gillespie's new territory, which includes Western Canada, Montana, Wyoming and Colorado. The Denver district office is not affected by this change, McKinney explained, and the manager there, C. L. Bainter, will continue to supervise the National Supply stores at Craig, Colorado, and Rock Springs, Wyoming.

R. M. Fifer, who formerly supervised National Supply operations in northern Montana, is the new district manager at Casper.

To manage Odessa store

R. L. Pebworth, former manager of The Continental Supply Company's Houston, Texas, store, has re-entered the company's employ as manager of the Odessa, Texas, store. He succeeds H. W. Carter, who will serve as field salesman at the same point.



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